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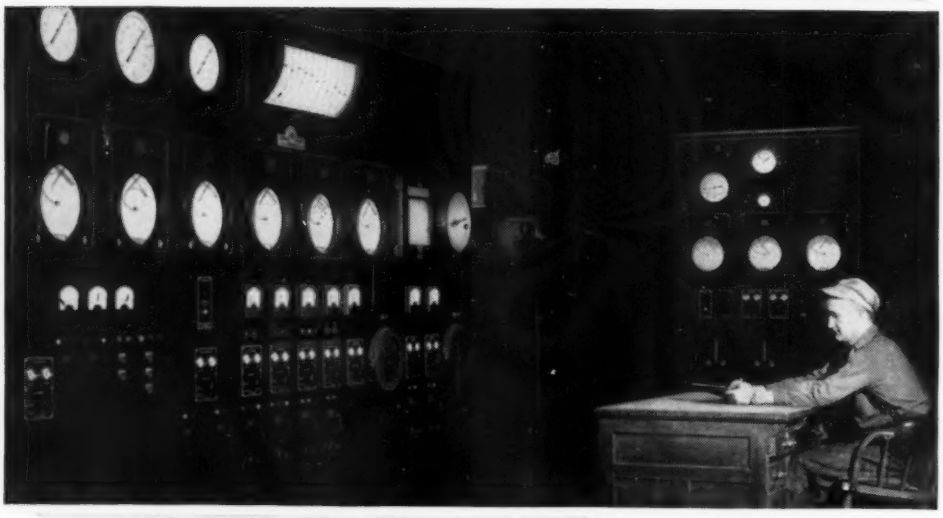
MECHANICAL ENGINEERING

MARCH 1945



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MECHANICAL ENGINEERING

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VOLUME 67 NUMBER 3

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Placing Portable Power Pump Preparatory to Extending Hose Line to Fire, Wisconsin

(See article in this issue "Foresters Request Co-Operation in Protection of Woodlands," pages 157–160.)

VOLUME 67
No. 3

MECHANICAL ENGINEERING

MARCH
1945

GEORGE A. STETSON, *Editor*

William B. Gregory

WILLIAM B. GREGORY, who died on Jan. 29, 1945, had served one term as manager (1916–1919) and two terms as vice-president of The American Society of Mechanical Engineers (1920–1921 and 1931–1933) and received the Worcester Reed Warner medal in 1940 "for distinguished work in hydraulic engineering which has been the basis of many engineering papers." A native of New York State and graduate of Cornell University in 1894, he became, that same year, an instructor in experimental engineering at Tulane University. Thus began a long and fruitful career in engineering education and consulting practice. In 1938 he retired as professor of experimental engineering at Tulane but he continued the practice of engineering until his death.

Professor Gregory's career was closely associated with the engineering problems of the Lower Mississippi Valley. In 1905 he competed in Civil Service examinations for a position as irrigation engineer and was first on the list of 109 applicants. From 1904 to 1925 he worked during the summer studying problems of rice-field irrigation, drainage, and the pumping of water in Louisiana, Texas, and Arkansas. From 1898 until his death he served as consulting engineer to many firms and municipalities, making acceptance tests of steam and Diesel engines, boilers, pumps, and other equipment, and was twice consulting engineer to the Mississippi River Commission. Returning to Cornell University in 1907–1908 for graduate study, he was awarded the degree of Master of Mechanical Engineering by that University.

From 1917 to 1919 Professor Gregory was on leave of absence from Tulane University while serving as Major of Engineers, United States Army, in France, where he was assigned to the problem of supplying water to the front lines. For this work he received a citation and the decoration of the Purple Heart. After the war he continued as a lieutenant colonel and later colonel of engineers in reserve.

A long list of technical papers, bulletins, and reports attest Professor Gregory's work in the field of engineering literature. In 1930 he visited the hydraulic laboratories of Europe with John R. Freeman and, based on his observations, he designed and built a hydraulic laboratory for Tulane University. He was a member of the Engineering Commission on Bonnet Carre Spillway.

After his retirement from teaching, Professor Gregory spent a year as engineer examiner with the P.W.A. Fifth Area Office, Fort Worth, Texas; and later, at Hammond, La., he was resident engineer inspector on approximately a million dollars' worth of buildings.

Professor Gregory typified the high qualities of the engineer-teacher of his times. His teaching was continuously enriched and refreshed by his experiences as a consulting engineer, while his position as a member of an engineering faculty inspired confidence in his knowledge and integrity. He began his career at Tulane as instructor in experimental engineering and superintendent of the steam plant, but the engineering problems of the region in which he lived lay so abundantly in the field of irrigation, drainage, and pumping that he became an expert in hydraulic engineering. He served his fellow men by directing his energy and his talents to matters which were their greatest concern.

E.C.P.D. Poses Problems

THE immediate future will demand intelligent decisions and positive action by engineers in respect to their profession. War, with its upheavals, dislocations, changes in social and economic environment, interruptions of programs of education and patterns of practice, has amassed a great variety of real problems for solution; and while the passage of time will bring these problems into sharper relief, solutions will be reached more quickly if all engineers do some thinking about them now. What the engineering profession of the future will be like will depend to a large extent on what engineers do about the problems that are growing up today. It is toward this end that the Engineers' Council for Professional Development is working under the severe handicap of wartime conditions. E.C.P.D.'s current activities and its awareness of some of the problems facing the profession are to be found in its twelfth annual report which is now being distributed.

The Engineers' Council for Professional Development is "a conference organized to enhance the professional status of the engineer through the co-operative efforts of . . . national organizations concerned with the professional, technical, educational, and legislative phases of engineers' lives." These national organizations are the five American engineering societies A.S.C.E., A.I.M.E., A.S.M.E., A.I.E.E., and A.I.Ch.E., and The Engineering Institute of Canada, The Society for the Promotion of Engineering Education, and the National Council of State Boards of Engineering Examiners. Now in its thirteenth year, the Council from the start divided its work into four major fields by the establishment of four standing committees—Student Selection and Guidance, Engineering Schools, Professional Training, and Professional Recogn tion—which cover the four phases of the engineer's status from the time he considers an engineering education to his ultimate emergence as a practicing engineer of recognized standing.

Twelve years of pioneering work have made these four standing committees powerful influences in the engineering profession. The Committee on Student Selection and Guidance has concerned itself with the

development of two projects: (1) The advisement, counseling, and guidance of students about to enter college, which includes the wide distribution of a pamphlet, "Engineering as a Career;" and (2) the development of a battery of tests to aid in the proper selection of students for engineering.

More recently, guidance activities have been extended to include the use of the material the committee has developed by the Armed Forces and the Veterans Administration. An important current and future activity is the aid that can be given to young men discharged from the Services and re-entering private life. Measurement of the effectiveness of the guidance and selection activities of the committee is at present being aided by a study under the direction of the Carnegie Foundation for the Advancement of Teaching. The postwar world, which will witness the return of the engineering schools to peacetime programs and the need for retraining of thousands of young men released by the Armed Forces, poses many problems for this committee and offers exceptional opportunities to serve not only the engineering profession but the nation as well.

Accreditation of the curricula of engineering schools has been the major task of the Committee on Engineering Schools. So thoroughly and effectively has this work been done that, up to the time the war interrupted the normal educational programs and drained from the engineering faculties some of their best members, graduation from an engineering school with accredited curricula was recognized by engineering societies and state boards of engineering examiners as evidence of satisfactory educational preparation for an engineering career.

The procedures of accreditation improved the quality of the engineering schools by directing attention to deficiencies in curricula, in teaching staff, in equipment and educational facilities, and in budgets. The return of peacetime conditions will bring with it new problems for the committee to solve and leave with it many others arising out of educational programs adopted because of the war.

One effect of the war has been the increased importance of the technical institute. Accreditation of the curricula of technical institutes was not undertaken by the committee during the first twelve years of its existence, but during the past year a Subcommittee on Technical Institute Programs has been appointed.

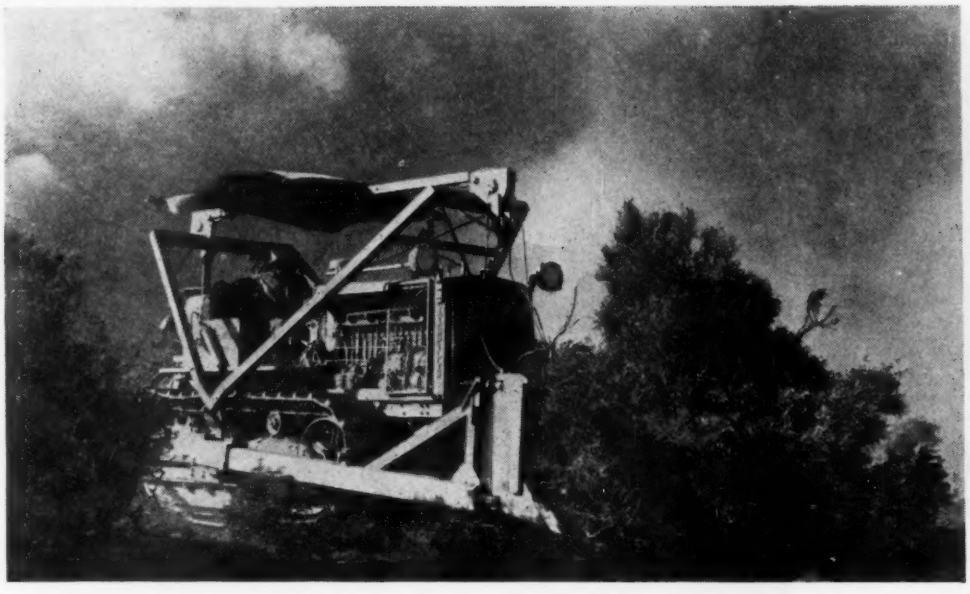
Recognizing that there exists between graduation and the acceptance of the graduate into the engineering profession as an engineer of full stature a period of years in which the young man is attempting to establish himself, the E.C.P.D. Committee on Professional Training has developed certain aids to self-advancement. Its early work consisted in issuing a self-appraisal blank by means of which the young engineer might acquaint himself with his needs and formulate plans for his future. A Selected Bibliography on Engineering Subjects and a reading list to stimulate nonengineering interests have been widely distributed. A revised reading list is now available and plans for periodic revision have been announced. A "Manual for Junior Engineers" is in process of preparation. The far-reaching effects of the war on the lives and careers of recent engineering graduates has greatly increased the opportunity of the Committee on Professional Training for aid in readjustment to the conditions the peace will impose.

By far the most perplexing task of E.C.P.D. lies in the work of the Committee on Professional Recognition. Early optimism that criteria of recognition could be established met with disappointment and led the committee, under the chairmanship of C. F. Scott, to turn "to the engineering colleges in the hope of developing in the new generation a reasonably clear professional purpose—a professional consciousness and likemindedness—that the present generation of engineers does not have." In furthering its objective "to develop methods whereby those engineers who have met suitable standards may receive corresponding professional recognition," the committee adopted the "minimum definition of an engineer," and urged action relating to proposed standard grades of engineering-society membership, uniformity in new registration laws, and simplification and uniformity in engineering-school degrees. Present conditions and those anticipated to develop after the war increase rather than diminish the difficulty of the task confronting the committee. However, it is generally agreed that acceptance by the public of engineering as a profession and the enhancement of individual and group status as a result of such acceptance depend in a large measure on a successful solution of the problems confronting the committee.

Some progress has been made by the Committee on Principles of Engineering Ethics in obtaining acceptance, in principle at least, of the proposed Canons of Ethics. Inasmuch as a distinguishing feature of a profession is the code by which its members regulate their professional conduct, agreement on ethics is of prime importance to the future of the engineering profession. It is not enough to be honest, fair, and well-intentioned. It is not enough to protect the public or one engineer in respect to another. The aim should be to set standards and proscriptions of conduct and to safeguard them effectively so that the engineer cannot be induced by his client, employer, or government to violate them and is protected against reprisals for refusing to violate them.

The Engineers' Council for Professional Development grew out of an attempt to improve the economic status of the engineer, and yet any suggestion of adopting the strategy, tactics, and form of organization of the trade or industrial union would have been indignantly denied. Today hundreds of engineers are members of unions and many more are faced with the alternative of forming their own unions or being forced to join already established unions. A review of the situation in the United States and Canada is presented in the report of the E.C.P.D. Committee on Employment Conditions for Engineers and was published in the December, 1944, issue of MECHANICAL ENGINEERING.

Decisions that are taken in respect to the question of unionization will profoundly affect the engineering profession. It is probable also that the character of the activities of engineering societies will be greatly affected by the decision. If considerations of employment conditions are to result in restrictions on the individual and lead to disciplinary controls by groups whose major concern is economic status and vested interest, then engineers may be well paid and have a protected economic status, but engineering will suffer a setback.



TRACTOR AND BULLDOZER CLEARING CONTROL LINE THROUGH BRUSH, CALIFORNIA

Foresters Request Co-Operation in PROTECTION *of* WOODLANDS

Proposal for a Joint Committee of the Society of American Foresters and The American Society of Mechanical Engineers

By HENRY CLEPPER and DAVID P. GODWIN

EXECUTIVE SECRETARY, SOCIETY OF AMERICAN FORESTERS, AND ASSISTANT CHIEF, DIVISION OF FIRE CONTROL, U. S. FOREST SERVICE, WASHINGTON, D. C.

UNDER the sponsorship of the Wood Industries Division, a special conference on forest conservation and forest-fire control was called Nov. 28, 1944, in connection with the Annual Meeting of The American Society of Mechanical Engineers in New York, N. Y.

At this conference, the writers presented a proposal for the creation of a joint committee of the Society of American Foresters and The American Society of Mechanical Engineers to give advice and direction in the research, design, and development of equipment used in forestry work, particularly in forest-fire control, and in the forest-products industries.

PURPOSE AND OBJECTIVE OF COMMITTEE

The purpose and objective of this joint committee would be to determine the specific types of mechanical equipment used in forestry work on which certain improvements in design, construction, and adaptability are needed.

It would be the duty of the forestry representatives on the committee to determine the specific kinds of equipment on which work in the field of research and improvement is needed. Initially, such types of equipment may be limited to a few important items in the field of forest-fire control. Later, if the activities of the committee are successful, the number of items can be expanded.

It is proposed that the engineering representatives on the committee make appropriate recommendations to available research centers and laboratories where improvements in design and construction might be undertaken. It is believed possible and logical that certain of these research projects might be centered in schools of engineering at colleges and universities where schools of forestry are also located. In some cases the engineering representatives might recommend that certain problems be referred to privately endowed research organizations or to the research staffs of manufacturing firms. It is believed possible for the two professional organizations to co-operate for their mutual advantage and to promote progress in their individual fields.

As regards the forestry interests involved, co-operation will be assured through participation of federal organizations such as the Forest Service, U. S. Department of Agriculture, interested state and municipal organizations, and the forest-products industries.

A large committee is not needed at the outset. Probably three carefully selected men from the forestry profession can adequately cover the field. One such member would represent the Forest Service, another might represent state organizations, and a third the forest-products industries. Eventually, it may be desirable to have subcommittees working on specific problems.

PORTABLE PUMP AND HOSE CREW PACKING EQUIPMENT TO THE WATER SUPPLY, WISCONSIN

Suggestive of the types of equipment on which further research and development are needed are the following:

Demountable Fire Finder. Present forest-fire finders are bulky and obstruct free movement in the small quarters of the lookout man. The Forest Service has already started preliminary designs on one which will be mounted on the floor and can be taken down with ease. It must be designed so as to permit azimuth shots and avoid obstructions to vision.

Fire Finder Employing Photoelectric Cells. This device has not been developed in any way. The possibility has been suggested that distinct smokes may be located through the employment of some device on the principles of the electric eye.

Trenching Machine. A self-propelled walking tractor with revolving hammers or brush powered by small light engine (5 to 10 hp) which will dig out or scuff out a shallow trench approximately 3 in. deep and 15 in. wide.

Fire Line Plow. A small moldboard plow for construction of fire line, to be drawn behind light crawler tractor. Many plows have been designed and used for this purpose but none is fully satisfactory.

Light Gasoline Engine. In the range of 5 to 8 hp, it must have best possible weight-to-horsepower ratio. There is nothing entirely suitable on the market. It must be adaptable as power unit to several important pieces of fire-control equipment.

High-Pressure Fog Units. A lightweight pump and engine producing not more than about 10 gpm with high pressures in the order of 500 to 600 psi. Preferably, it should be developed

TUNING UP PORTABLE POWER PUMP PRIOR TO USE ON FIRE, IDAHO

BUILDING CONTROL LINE ALONG FIRE'S EDGE WITH TOOLS
(Cross-cut saw, shovel, Pulaski tool, and backpack pump, South Dakota.)

TRENCHING MACHINE CONSTRUCTING NARROW LINE ALONG FIRE'S EDGE

(Power transmitted by light gasoline engine through vertical shaft to hub which mounts loose-hung hammers, Montana.)

as a skid or slip-on unit to be placed in truck body along with water tank and hose. Such devices are available from a few manufacturers (notably the John Bean Company), but they have been designed primarily for farm spraying or for structural fire fighting.

Backpack Pump. To improve on present types. Tank capacity, 5 gal. It is desirable to develop some pressure method as improvement over present trombone pump.

Scooter. Rugged, one-man vehicle for travel of smokechaser on mountain trails. Some work has been done in revision of standard model but changes are needed in power and gearing.

Flame Thrower. For backfiring. Various models have been developed but none is fully satisfactory. Army flame thrower is too complicated and provides more fire than necessary. Two types may be necessary: (1) Flame under pressure and (2) drip-torch type.

Metals. Forestry agencies know little about recently developed lightweight metals, steel and aluminum alloys and magnesium, which are very necessary in forest types of machines where portability in rough remote country is important.

THE FOREST PROTECTION PROBLEM

Approximately one third of the area of the United States is forested. Of this forested area about one third (306,000 square miles) is included in the national forests and under organized fire protection by the U. S. Forest Service. About one half of the country's forested area (469,000 square miles) is under some degree of organized fire protection directed by 43 state governments and by certain private owners or associations.

The protection system built and maintained by the U. S. Forest Service represents a great outlay of facilities:

Roads (miles)	126,500
Trails (miles)	151,000
Telephone lines (miles)	63,500
Fire breaks (miles)	10,800
Lookout stations	3,200
Landing fields	85
Buildings (various use)	18,000
Radio stations	3,400

LOOKOUT MAN SIGHTING AND LOCATING FOREST FIRE FROM TOWER

(The instrument records both azimuth and vertical angles, New Hampshire.)

Numerous other agencies, government and private, have similar facilities.

A great variety of tools, devices, and machines are used by these agencies in conducting the work of fire prevention, detection, and suppression. The "Fire-Control-Equipment Handbook" of the Forest Service contains about 800 different items. The present equipment inventory is about $8,000,000.

Despite these heavy investments and a large trained field personnel, the damage to the nation's timber resource by fire in the year 1943 was $46,500,000. Undoubtedly, this heavy annual loss can be gradually reduced by more manpower, intensified training of supervisory personnel, and improvement in the techniques of fire suppression, but it is reasonable also to assume that improvement and modernization of mechanized tools will help measurably to improve the record and reduce destruction of the forest resource.

The Forest Service has shops for maintenance and repair of heavy equipment in all regions but conducts only one shop in the nature of a laboratory for experiment and development (Portland, Oregon). The establishment of three others is contemplated. However, devising, adapting, and developing are proceeding with varying and usually limited skill and facilities throughout the national-forest areas.

NEED FOR PROFESSIONAL ENGINEERING AID

Broadly speaking, forest fires are extinguished in two ways: (1) Construction of control lines around the fire followed by burning out and (2) application of water or other fire-extinguishing elements to the burning material. Consequently, main attention should be directed to cutting, digging, and water-dispersing devices.

In the field of equipment development the Forest Service believes that it has not sufficient professional knowledge, particularly in the design and assembly of mechanized units. This lack could be partially met by the employment of a capable mechanical engineer at each proposed development center. Mechanical engineering, however, embraces many specializations, and it seems unlikely that one man would be fully qualified in all the varied fields.

It is most desirable therefore that foresters as a group establish a means of intercourse with the A.S.M.E. as an aid in the solution of the many problems of machine equipment which the jobs of fire control, timber harvesting, and reforestation present.

Foresters would greatly appreciate the opportunity to consult with the A.S.M.E. through an established committee. Frequently, the need would probably be satisfied by advice as to who could do what; names of manufacturers or shops, research or experimental laboratories, individuals specializing in various fields, whether in industry or public institutions. Our development programs must be consistent and sustained, so it is hoped that our relations with the A.S.M.E. will involve recurrent conferences, semiannually or annually.

CONCLUSION

Should this proposal for a joint committee be considered favorably by The American Society of Mechanical Engineers, the Society of American Foresters would recommend as its first appointee, and chairman of the forestry group, David P. Godwin, co-author of this paper. Mr. Godwin has been designated by the chief of the Forest Service to head a committee of forest officers in the various Forest Service regions. This committee has as its function to stimulate and support activities in the nation-wide fire-control-equipment field to aid in searching out promising items, to co-ordinate the efforts of all interested persons and agencies, and to have general direction of development and testing projects financed by federal funds.

It is suggested that, in a larger sense, the joint committee of the two societies might perform the same function on a national basis and for all interested agencies, federal, state, and private.

It is not anticipated that the joint committee would in any sense undertake specific research and development projects on its own. It would largely serve as a steering committee to determine which research and development projects were most important and then attempt to have such projects assigned to those engineering centers which might be best equipped to work on them.

PORTABLE POWER FLAME THROWER BEING USED AT NIGHT TO BACKFIRE FROM ROAD, CALIFORNIA

HANDLING *and* BURNING FUELS *On Board* AMERICAN SHIPS

By D. M. SCHOENFELD[1] and G. P. HAYNES[2]

MARINE boilers are fired by either oil or coal as dictated by practical considerations. The choice, in the case of merchant ships, is determined primarily by economics. In the case of naval vessels, military considerations will govern.

FACTORS INFLUENCING CHOICE

When vessels burn fuel oil, they may be fueled in a shorter time than those that burn coal. In fact, oil-burning ships are usually bunkered while discharging and loading cargo. Hence less time in port is required for this function. This is important to those ships especially that operate on a quick turn around, such as passenger ships. It also is becoming of increasing importance to merchant ships, as improvements in cargo-handling equipment are receiving increasing attention. The operation of fueling and the transfer of the fuel oil from the points of storage to the ship may be performed mechanically instead of manually so that it is cleaner than bunkering coal. The same holds true in handling the fuel oil aboard ship.

Fuel oil has no ash-disposal problem. Although equipment is available for handling coal and ash mechanically, it is expensive compared to that required for fuel oil and occupies more space that may be used to better advantage otherwise. Finally, fuel oil weighs less and occupies less space per unit of heating value than coal so that a lower weight of fuel oil will yield the same radius of operation and will occupy less space, thus allowing that much additional revenue-producing weight to be carried.

The cleanliness in handling and the less arduous labor in firing oil as compared to coal, most of which is still fired by hand and must be trimmed by hand, result in a smaller number of personnel required to operate a ship. For the same reasons, it is possible to attract higher-grade and more skillful personnel and there is less turnover. These are additional economic factors favoring oil.

Coal is available at East Coast ports at a lower price on heating-value basis than fuel oil, but this is offset by the advantages set forth for fuel oil. The distance that coal must be transported to ports located on the Gulf and Pacific Coasts makes its cost there such that it is seldom able to compete with fuel oil.

The foregoing serves to explain why nearly all ocean-going American tonnage propelled by steam uses fuel oil rather than coal.

Out of the processes of refining crude petroleum for the purpose of obtaining its most valuable and volatile constituents, there are remaining residues of somewhat varying characteristics. Often these residues are of such a nature that lighter distillates are necessarily blended with them to produce a product with sufficient fluidity for practical handling. Such residual oils commonly bear the name of "fuel oil," or bunker C oil. An average commercial analysis would be as follows:

Carbon, per cent	86.4
Hydrogen, per cent	10.7
Sulphur, per cent	1.5
Nitrogen plus oxygen, per cent	1.0
Water, per cent	0.3
Sediment, per cent	0.1
Heating value, Btu per lb	18500
Flash point, deg F	175
Fire point, deg F	225
Specific gravity	0.975

Along the East Coast some special coastal vessels, such as colliers and quite a few harbor craft, such as tugs and ferries, find it expedient for economic or other reasons to fire their boilers with coal. Anthracite is generally preferred since it is cleaner and does not smoke. Likewise, many foreign vessels burn coal. When supplied at East Coast ports, they are usually fueled with low- or high-volatile bituminous coals from Pennsylvania, West Virginia, Virginia, and eastern Kentucky. Representative proximate analyses of these high-grade coals are given in Table 1.

TABLE 1 PROXIMATE ANALYSES OF VARIOUS COALS

	Low-volatile bituminous	High-volatile bituminous	Anthracite
Moisture, per cent	2.6	3.0	5.5
Ash, per cent	5.9	6.2	10.5
Fixed carbon, per cent	73.7	57.0	80.0
Volatile matter, per cent	17.8	33.8	4.0
Sulphur, per cent	0.9	1.3	0.7
Heating value, Btu per lb (as received)	14300	13800	11200

On the Great Lakes nearly all ships burn coal. Here coal enjoys an attractive price differential over fuel oil largely because of favorable differences in transportation charges. Furthermore, many of the ships operating on these waters are engaged in transporting coal, frequently at least, on one leg of a trip, or are owned by interests closely allied with the coal-producing industry. The coals burned on these vessels, although occasionally equal to, are generally not of such high grade as in the case of ocean-going ships. Representative proximate analyses are given in Table 2.

TABLE 2 PROXIMATE ANALYSES OF COALS USED ON GREAT LAKES VESSELS

Moisture, per cent	2.2	3.5	3.5
Volatile matter, per cent	34.1	33.2	34.1
Fixed carbon, per cent	58.3	54.6	50.0
Ash, per cent	5.4	8.7	12.4
Sulphur, per cent	0.8	1.3	2.0
Heating value, Btu per lb (as received)	14240	13300	12540

BUNKERING FUEL OIL

Delivery of fuel oil on board a vessel may be from an oil barge or from a shore station. The former is employed most frequently as delivery may be made while the vessel is discharging or taking on cargo. Flexible connections are made from the barge to the filling line on the ship. The oil pump on the barge is supplied with steam, either from a boiler on board the barge, or by a flexible steam line from the vessel being bunkered. This steam supply is also tapped for heating the oil prior to pumping.

[1] Assistant Manager, Marine Department, Combustion Engineering Company, Inc., New York, N. Y. Member A.S.M.E.

[2] Chief Engineer, Todd Combustion Equipment Division, Todd Shipyards Corporation, New York, N. Y.

Contributed by the Fuels Division and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of The American Society of Mechanical Engineers.

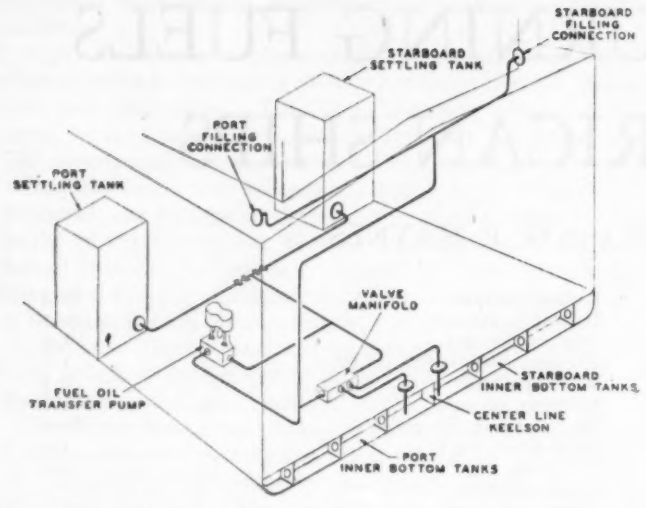


FIG. 1 SCHEMATIC ARRANGEMENT OF FUEL-OIL BUNKERS, DEEP TANKS OR OIL SETTLERS, ETC.

The number and arrangement of tanks in a vessel is usually somewhat more complex than in a shore plant, as a result of the construction of the hull and the desire of the naval architect to utilize the available space efficiently, providing oil storage with minimum interference with cargo and machinery space. Fuel oil also offers a convenient means for maintaining the stability of the ship, as an oil-storage tank after being drained may be filled with water for ballast. The fuel-filling system is preferably arranged with overflows so that while bunkering it is necessary only to observe the level of the oil in one or two tanks. Such an arrangement permits bunkering at maximum speed with slight danger of loss from overflowing. The amount of oil in each tank is determined by direct soundings or by a gage. A schematic arrangement is shown in Fig. 1.

As a part of the oil-tank system on board a vessel, it is customary to provide two deep tanks so located that the suction connections from them are above or nearly level with the fuel-oil service pumps. Each such tank is usually of adequate capacity to operate the vessel for 30 hours. These tanks are also known as fuel-oil settling tanks, and their purpose is to provide the means for settling out any water that may be entrained in the fuel oil. Most water remains in the double-bottom storage tanks as a result of incomplete drainage after being used as ballast tanks. These settling tanks are filled with fuel oil from the double-bottom or deep tanks by a fuel-oil transfer pump, usually utilizing the filling-system piping. The latter tanks are provided with steam-heating coils of sufficient area to reduce the viscosity of the oil to a degree where it is readily pumpable. The fuel-oil settling tanks are provided with a series of steam grids which cause the water to precipitate by lowering the viscosity of the oil and helping to break emulsions. A period of 24 hours is allowed for this conditioning process, following which the water is stripped off and disposed of. The condensate from the steam coils and grids is trapped and inspected for possible presence of oil due to leakage before it is returned to the boiler-feed system.

From the fuel-oil settling tanks the oil passes into the suction of the fuel-oil service pump, thence through the preheaters to the burners. Strainers at the suction and discharge of the fuel-oil service pump protect the pump and the burners from becoming fouled by any foreign substance present in the fuel oil. The schematic arrangement of this equipment is illustrated in Fig. 2, and an actual arrangement in Fig. 3.

FUEL-OIL BURNERS

A burner for fuel oil consists essentially of two parts, the atomizer for converting the stream of solid fuel oil into finely divided particles, and the air register for introducing most effectively the air required for combustion among the finely divided particles of fuel oil. A number of different means or designs may be employed to achieve these ends. There are four types of atomizers in common use as follows:

1 Straight pressure or mechanical atomizer.
2 Straight pressure atomizer with return flow of fuel oil (wide-range atomizer).
3 Steam atomizer.
4 Rotary-cup (spinning-cup) atomizer.

The atomizing principle used in the mechanical atomizer, shown in Fig. 4, consists of delivery of several streams of fuel oil at high velocity through passages discharging tangentially into a small cylindrical chamber that verges into a cone with a discharge orifice at its apex through which the oil is sprayed into the boiler furnace. To obtain the high velocity required to produce a suitably fine spray, pressures ranging from 75 to 300 psi are used, and the fuel oil is heated to a temperature where its viscosity will be 150 SSU. The centrifugal and axial

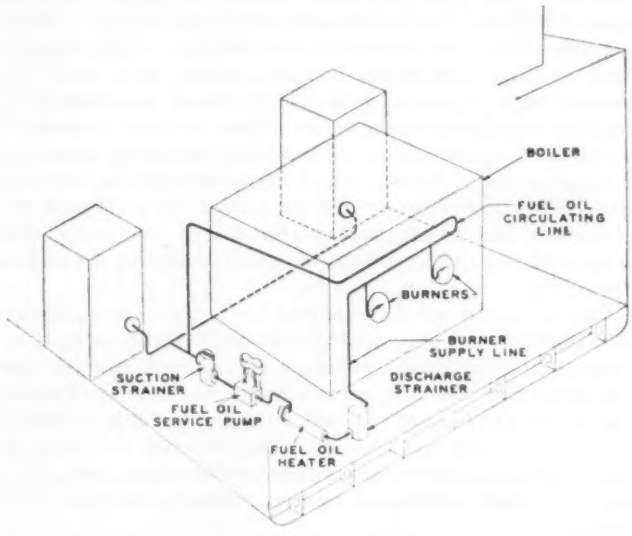


FIG. 2 SCHEMATIC ARRANGEMENT OF FUEL-OIL SERVICE PUMPS, HEATERS, STRAINERS, AND BURNERS

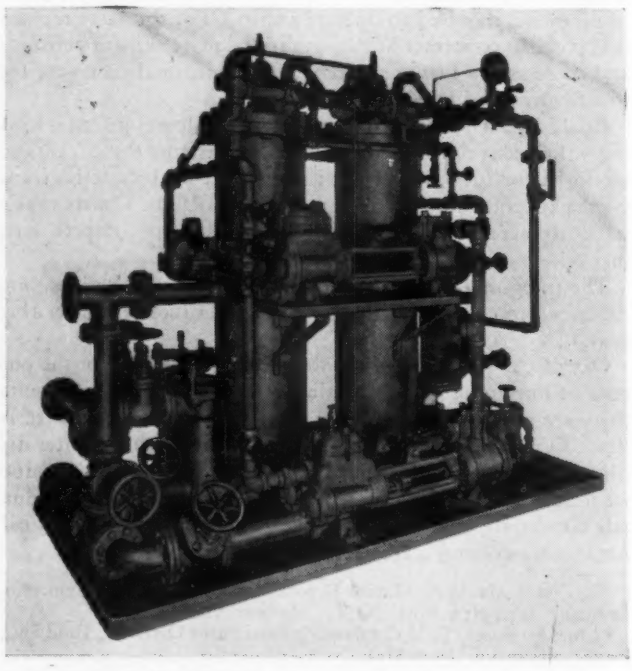


FIG. 3 ACTUAL ARRANGEMENT OF FUEL-OIL SERVICE PUMPS, HEATERS, AND STRAINERS

forces set up in the chamber result in the production of a hollow conical spray. The designer has considerable latitude as regards the spray angle and fineness of atomization by changes in the shape and dimensions of the chamber, the number and dimensions of the tangential passages, the ratio of their total area to the area of the outlet orifice, etc. The capacity for any given orifice size varies closely with the square root of the supply pressure. With the pressure range noted, the operating range of this type of atomizer is limited to a quantity ratio of 1:2. In this type of atomizer all the oil entering the chamber is discharged into the furnace.

Mechanical atomizers, illustrated in Fig. 5, with return flow have been developed to secure an increase in operating range. This is accomplished either by supplying to the whirling chamber a greater quantity of fuel oil than is to be discharged and returning the excess to the supply pump suction, or by varying the area of the tangential passages into the whirling chamber by an adjustable sleeve or plug. By either method the object is to maintain high enough velocity through the tangential passages for a good degree of atomization. With the return-flow principle, the range can be increased to as high as 1:10, depending upon furnace conditions and the maximum rate of firing. In the movable-plug design, the range can be increased to 1:4. Views of an oil burner showing a straight mechanical atomizer and the air register are shown at the right in Fig. 4.

As the name implies, the steam atomizer employs steam as the atomizing agent. It is usually constructed to secure a number of steam jets directed so as to impinge on an equal number of small streams of solid oil as shown in Fig. 6. The impingement breaks up the oil to produce an effect similar to the hollow cone-shaped spray obtained with the two types of straight pressure atomizers. In this type of atomizer, it is necessary to preheat the oil to a temperature high enough to reduce the viscosity to 300 SSU. The oil-supply pressure may be varied from 5 to 300 psi. The steam pressure relative to the oil pressure is

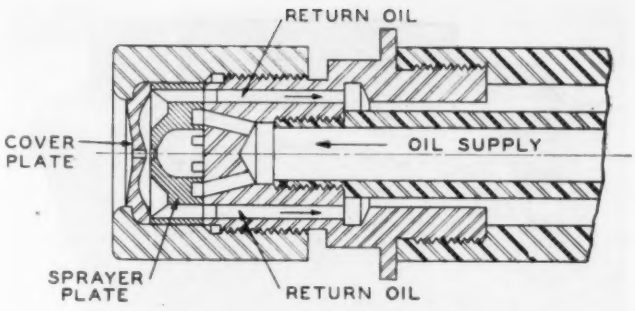
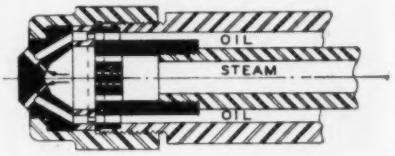


FIG. 5 RETURN-FLOW MECHANICAL ATOMIZER

FIG. 6 STEAM ATOMIZER



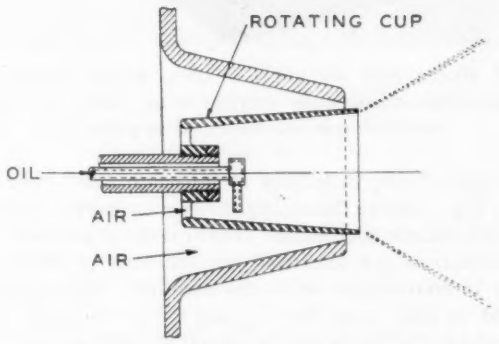
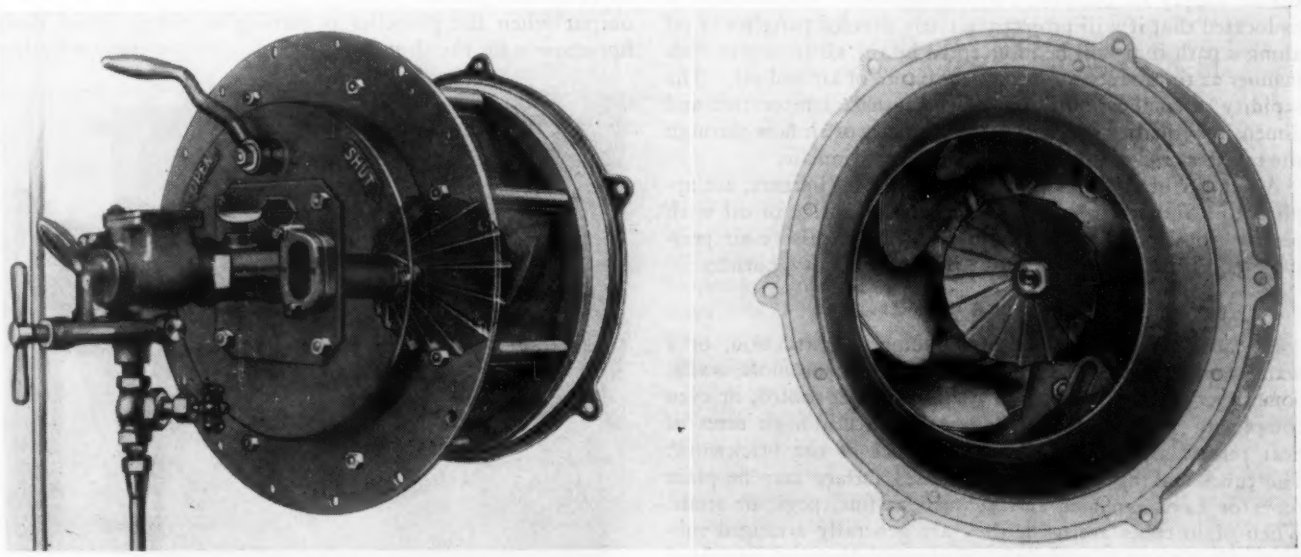


FIG. 7 ROTARY OR SPINNING-CUP ATOMIZER



(Right, view of actual oil burner showing straight mechanical atomizer and air register.)

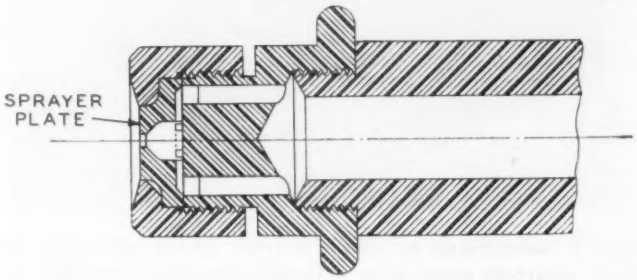


FIG. 4 STRAIGHT MECHANICAL ATOMIZER

maintained at a constant differential of about 10 psi by use of a differential valve. A flow ratio of 1:10 may be realized. No widespread application of this type of atomizer on board ship has yet occurred. Many operators object to the steam loss, especially where it must be made up by evaporation.

The rotary-cup atomizer consists primarily of a cup shaped like the frustum of a cone and rotating at about 3400 rpm. Oil at 300 SSU is delivered into the rear of the cup and is centrifuged off the leaving edge as a thin film normal to the axis of the cup. Here it is intercepted by a blast of primary air flowing at high velocity parallel to the axis of the cup. This air blast breaks

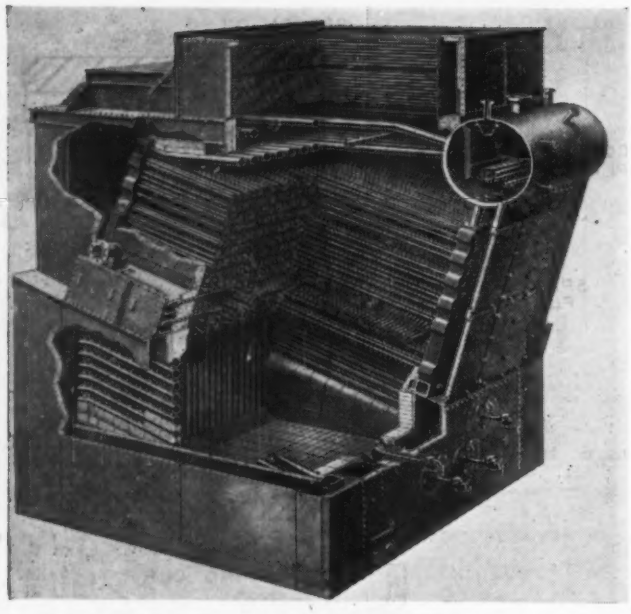


FIG. 8 SINGLE-PASS SECTIONAL-HEADER BOILER INSTALLED IN U. S. MARITIME COMMISSION VICTORY SHIPS, SHOWING ARRANGEMENT OF SIDE WATERWALLS IN FURNACE

up the film of oil, deflecting it into a hollow cone-shaped spray. Fig. 7 shows the arrangement of a rotary-cup atomizer.

For the efficient combustion of the oil spray produced by any of the atomizers just described, it is necessary to employ an air register in conjunction with the atomizer. Air registers are designed so that they may be adapted to the type of draft under which the boiler unit is operated, such as forced draft, induced draft, or natural draft. The direction and velocity of the air supply are controlled by the register. The atomizer is so located that it will project the finely divided particles of oil along a path that will be intercepted by the air stream in such manner as to produce an intimate mixture of air and oil. The rapidity of combustion is affected by furnace temperature and dimensions, quality of atomization, velocity of air flow through the register, and temperature of the combustion air.

A number of atomizers and registers, or oil burners, are applied to a furnace to obtain the desired quantity of oil with proper atomization and without requiring excessive air pressure. Present boiler designs usually employ 3 or 4 burners.

OIL-BURNING FURNACES

Furnaces may be entirely of refractory construction, or a water-cooled surface may be applied to one or more walls. Sometimes the furnace floor is partially water-cooled, or even completely water-cooled. Waterwalls permit high rates of heat release and reduce the maintenance of the brickwork. The tubes making up the water-cooled surface may be plain tubes or have extended surface such as fins, pegs, or studs. When plain tubes are used, they are generally arranged substantially tangent to each other if of small diameter, or spaced from each other if of large diameter. Molded tile or plastic chrome ore is used between such tubes. When tubes with extended surface are used they are usually spaced about 2 diam from each other and a portion is covered by plastic chrome ore.

The furnace of a sectional-header-type boiler may be entirely of refractory construction, or water cooling may be applied to the two side walls, and to the rear wall. On the side walls the tubes are commonly disposed at the same slope as the tubes in the boiler bank and are expanded into headers arranged vertically at the front and rear of the setting. The front headers are fed by downcomer tubes and the rear headers are relieved by riser tubes, all connected into the steam drum. Vertically arranged tubes in the side walls have been used but the arrangement of the risers and downcomers is complicated, and all the wall tubes are of different lengths so that an increased number of spares must be carried. On the rear wall, vertical tubes are used, extending upward from a transverse header at the floor of the furnace and into the bottom of the uptake headers of the boiler. Downcomer tubes from the steam drum feed the lower header. Tube sizes normally used are 3 in., $3\frac{1}{4}$ in., or 4 in. OD. The different arrangements are shown in Figs. 8 and 9.

Furnaces of two-drum bent-tube boilers, as shown in Fig. 10, are always provided with water-cooled surfaces on the side wall and roof. The rear wall is often similarly water-cooled and occasionally even the front or burner wall. For the side wall and roof a header is located at the base of the side wall parallel to the water drum. This header is fed by large-diameter tubes, 4 in. or $4\frac{1}{2}$ in. OD, extending from the steam drum downward to the outer ends of the header. An alternative arrangement employs a number of smaller tubes extending from the water drum across the floor of the furnace and enclosed in the refractory. This latter arrangement provides a partially water-cooled floor and assures good distribution of water all along the side-wall header. The tubes of the side wall and roof discharge directly into the steam drum. When water cooling is applied to the rear or front walls, headers are provided at the floor and at the roof. The lower headers are fed from the lower drum by small tubes embedded in the floor. Risers disposed above the roof connect the upper headers to the steam drum. Tubes in the walls as well as risers and downcomers are all usually 2 in. OD.

Oil-burning marine boilers are often fitted with either economizers or air heaters. When the latter are used, the temperature of the preheated air seldom exceeds 350 to 400 F.

Compared to practice in shore generating plants, the rates of heat release used in the furnaces of marine boilers often cause surprise. In the case of boilers for merchant ships, the rate of heat release varies between 50,000 and 125,000 Btu per cu ft per hr at normal power. Normal power is defined as the boiler output when the propeller is turning at the designed shaft horsepower for the ship at full speed. Most merchant boilers

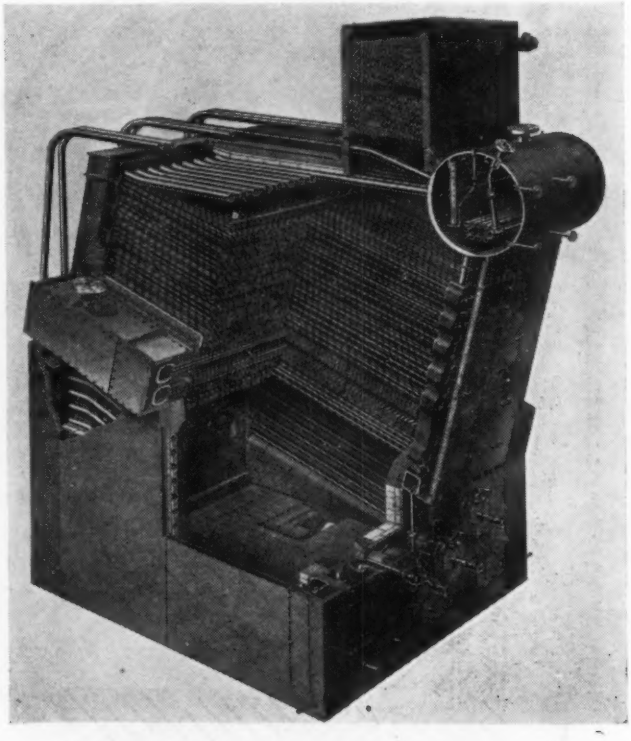


FIG. 9 SINGLE-PASS SECTIONAL-HEADER BOILER INSTALLED IN U. S. MARITIME COMMISSION STANDARD TANKERS, SHOWING ARRANGEMENT OF SIDE AND REAR WATERWALLS IN FURNACE

are designed for an overload output of 150 per cent of normal. Rates far in excess of these characterize practice in naval boilers.

Present trends seem to favor only a moderate degree of water-cooled surface in the furnaces of marine boilers, difficulty having been experienced with a high degree of water cooling in maintaining satisfactory combustion conditions at low rates of operation as exist when in port.

Excellent combustion conditions over an operating range extending from 50 per cent of full power to 150 per cent of full power can be attained with as little as 15 per cent excess air. Efficiency of the steam-generating unit is 87 to 88 per cent. A typical heat balance follows:

Dry-gas loss, per cent	5.25
Hydrogen loss, per cent	6.00
Moisture-in-air loss, per cent	0.15
Radiation and unaccounted for loss, per cent	1.60
Efficiency, per cent	87.00
Total, per cent	100.00

BUNKERING COAL

Ships burning coal under their boilers may fill their bunkers from either a shore station or a coal boat. Mechanical equipment is used but it is usually necessary to trim the bunkers manually.

Since most recently built coal-burning ships in this country are on the Great Lakes, attention will be directed toward them as representing modern practice. A large percentage of the recently constructed tonnage is of the class of vessels known as bulk carriers. These ships usually carry coal from Lake Michigan and Lake Erie ports northbound to the upper lakes and carry iron ore, grain, or limestone southbound. Coal is chuted directly into the hold of such ships from car dumpers. The ship's bunkers, generally located athwartship, are filled at the same time. They hold approximately 400 tons which is sufficient for the trip up the Lakes and back, a distance of 1700 to 1800 miles. If necessary to bunker coal from a coal boat, this is usually done while cargo is being loaded or discharged. A coal boat is actually a self-propelled barge fitted with a superstructure housing mechanical coal-handling equipment for discharging coal directly into the ship's bunkers.

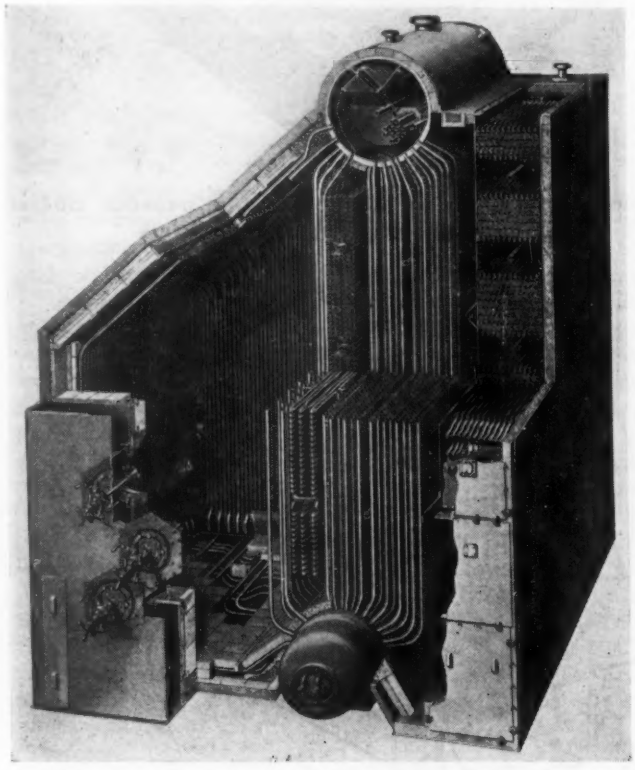


FIG. 10 FURNACE OF TWO-DRUM BENT-TUBE BOILER, SHOWING WATER-COOLED SIDE AND REAR WALLS AND ROOF, AS INSTALLED IN U. S. MARITIME COMMISSION C-CLASS CARGO SHIPS

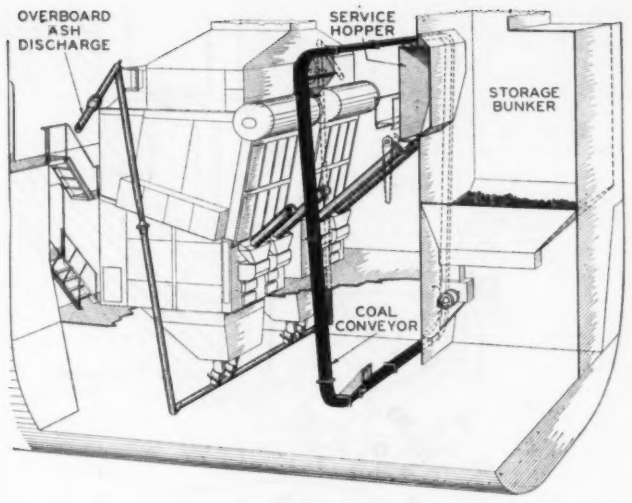


FIG. 11 ARRANGEMENT OF COAL BUNKERS AND COAL- AND ASH-HANDLING EQUIPMENT

Of course, the amount of coal bunkered by ships on the Great Lakes is not at all comparable to the quantities required by ocean-going vessels. Round trips on the Great Lakes seldom exceed 1800 to 2000 miles, and if the supply of coal begins to run low ports are close at hand where fuel may be replenished. Passages for which ocean-going vessels must bunker coal are at least 3 times this distance and often much greater, with generally no ports close at hand if the supply runs low.

From the bunkers, coal is carried by mechanical conveyer, through a crusher when necessary, to smaller auxiliary bunkers or hoppers feeding directly to the stoker hoppers as illustrated in Fig. 11. These auxiliary bunkers are filled about 6 times in 24 hr. In some of the older ships not fitted with conveying equipment, the stoker hoppers are filled manually.

STOKERS

Spreader stokers have gained wide popularity on board vessels on the Great Lakes. They have been included in all recently built vessels as well as those requiring reboilering. Applications have been made to water-tube boilers of both the sectional-header and bent-tube types and to Scotch boilers. Although stokers of the overfeed, underfeed, and chain-grate types were tried occasionally over a considerable period of time, their sluggish characteristics in responding to the wide and rapid variations in steam requirements during maneuvering made them unsuitable for such duty. The modern forced-draft spreader stoker overcame successfully this handicap and provided the additional advantages of being capable of handling coals of widely varying burning characteristics and of being responsive to simple systems of automatic combustion-control equipment.

The spreader stoker as applied to boilers in vessels on the Great Lakes is shown in Fig. 12 and consists of two or three units mounted on a cast-iron front. Each unit comprises the coal hopper, the feeder which measures the flow of coal in proportion to the steam requirements, and the distributor rotor which projects the coal into the furnace and distributes it onto the grate. The units are driven individually or from a jack shaft.

Coal sized to about $^1/_4$ in. to $^3/_4$ in. is fed from the hopper by the rotary feeder to the distributor. The rotary-type feeder has been found to provide positive control of the feed with wide ranges of variation in moisture content and sizing of the coal. The distributor consists of alternate rows of right- and left-hand blades attached to a rotating shaft to obtain equal distri-

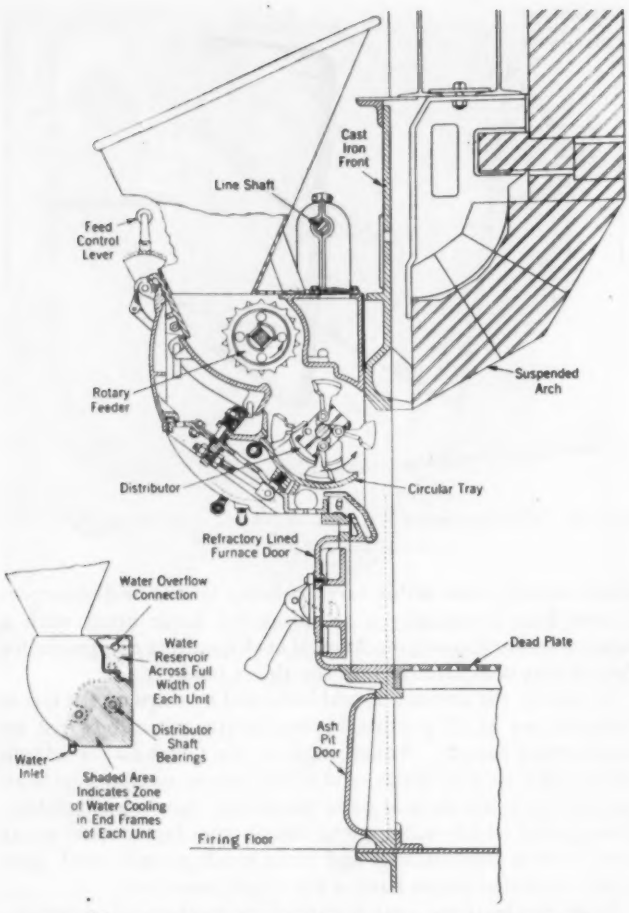


FIG. 12 SECTION SHOWING DETAILS OF SPREADER STOKER

bution of the coal over the grate surface. The speed of rotation determines the distance to which the coal is spread and is adjustable so that it may be fitted to different coal characteristics.

Most of the fines are burned in suspension. The larger pieces of coal burn on the grates. The grates are of either the stationary or the dumping type. Air is supplied both under the grate and over the fire. A number of recent installations incorporate means for recovering fly ash from the flue gas at the induced-draft fan and returning it with the aid of a small high-pressure blower to the furnace for additional burning.

COAL-BURNING FURNACES

The furnaces under sectional-header boilers usually have water-cooled surfaces in the side walls, the amount varying from 4 to 10 tubes in height in each wall. The arrangement, as shown in Fig. 13, is similar to that described for oil-fired boilers. The rear wall of such boilers is not water-cooled although it could be if desired. The furnaces of bent-tube boilers are water-cooled on the side wall and roof as well as on the rear wall, as described for oil-fired bent-tube boilers. As might be expected, combustion rates are necessarily lower than for oil-fired furnaces, averaging about 35,000 Btu per cu ft per hr at normal power. However, rates as high as 60,000 Btu per cu ft per hr have been used successfully. Combustion rates vary from 20 to 30 lb per sq ft of grate surface per hr at normal power, excess air from 35 to 40 per cent.

Many coal-burning boilers are equipped with air heaters. The temperature of the preheated air is generally in the range of 275 to 300 F.

Although such furnaces probably do not provide all the desirable conditions available in steam plants ashore, nevertheless good efficiencies are obtainable of the order of 83 to 85 per cent at the normal power of the boilers. A representative heat balance is as follows:

Dry gas loss, per cent	7.2
Loss due to hydrogen and moisture in coal, per cent	4.1
Moisture-in-air loss, per cent	0.2
Unburned carbon loss, per cent	2.5
Radiation and unaccounted for loss, per cent	2.0
Efficiency, per cent	84.0
Total, per cent	100.0

Many ships on the Great Lakes have hand-fired Scotch boilers. Naturally, the efficiency of such boilers is low and the hard manual labor involved makes it difficult to attract and hold skilled personnel. Spreader stokers have replaced hand-firing on a considerable number of such ships with such success that there is noticeable an increasing trend toward such modernization. A typical arrangement is shown in Fig. 14.

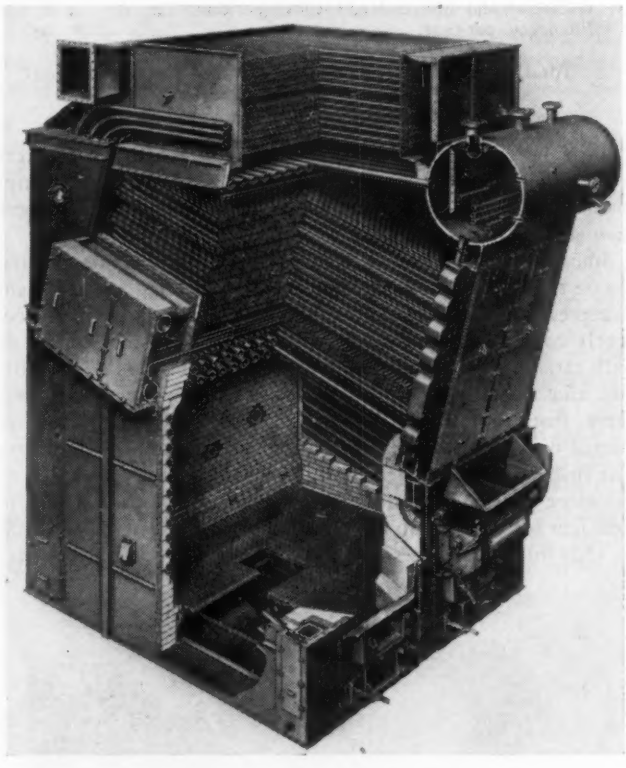


FIG. 13 SECTIONAL-HEADER BOILER AND SPREADER STOKERS, SHOWING WATER-COOLED SIDE WALLS

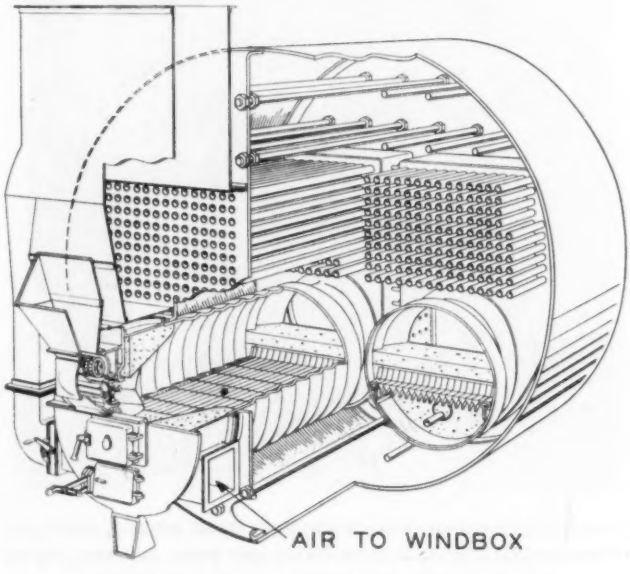


FIG. 14 SCOTCH BOILER AND SPREADER STOKER

The use of pneumatic ash-handling equipment is widespread on board ships on the Great Lakes. If dumping grates are installed, usually sufficient ashpit capacity is provided to accommodate the accumulation over a 24-hr period. With stationary grates, the ashes are pulled and accumulated at a convenient location on the firing floor. The ashes are disposed of overboard at points where this is permissible.

PULVERIZED COAL

Adaptation of pulverized-coal firing to marine boilers has been a subject of considerable experimentation. The pulverizing equipment is heavy by marine standards and the power requirements are high compared to stokers and to oil firing. On account of the restricted furnace volume, heat-release rates are high. Furnace maintenance is excessive, and heating surfaces become fouled by slag that is difficult to remove quickly and efficiently. Another handicap is the widely varying characteristics of the coals that must be burned. In general, the results have left much to be desired.

Colloidal fuel, which is a mixture of pulverized coal and oil, has never passed the experimental stage.

DRAFT—AUTOMATIC COMBUSTION CONTROL

The closed fireroom into which the forced-draft blower discharges directly and which is entered through an air lock is not used in modern ships. This arrangement is now superseded by an open fireroom with a modern ventilation system. The forced-draft blower discharges directly to a wind box surrounding the burners on the front of the boiler as in Fig. 15. This may be varied, depending upon the design of the boiler so that the wind box also surrounds the furnace or even the entire boiler as in Fig. 16. In other words, the furnace portion of the boiler setting, or the entire boiler, may be double-cased, with wind-box air pressure in the casing. Such designs preclude the escape of flue gases into the fireroom space. Such boilers operate entirely under forced draft. This arrangement is widely predominating in both merchant and naval tonnage.

Some few ships use induced draft and then the arrangement follows very closely the accepted practice in stationary steam plants and as shown in Fig. 17. Natural draft as shown in Fig. 18 finds but exceptionally limited application, usually only in small craft.

The foregoing applies to oil-fired boilers. Coal-fired boilers employ both forced and induced draft following closely on the lines applied in land plants. However, on the Great Lakes many vessels, although using one forced-draft fan for each boiler, employ only one induced-draft fan with a damper arrangement for by-passing the fan at light loads.

Automatic combustion-control equipment is often applied to boilers on board ship. The same types of control are used as for land boilers. However, simplicity of control and instrumentation is emphasized, only fuel and air generally being controlled to maintain constant steam pressure. Temperature indicators for total steam temperature, oil temperature, uptake-gas temperature, and air temperature if air heaters are fitted to the boilers, and two- or three-point draft gages are often employed. Steam flowmeters are almost never used.

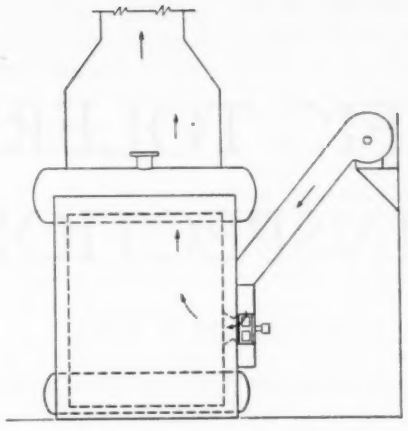


FIG. 15 FORCED DRAFT DIRECT TO WIND BOX

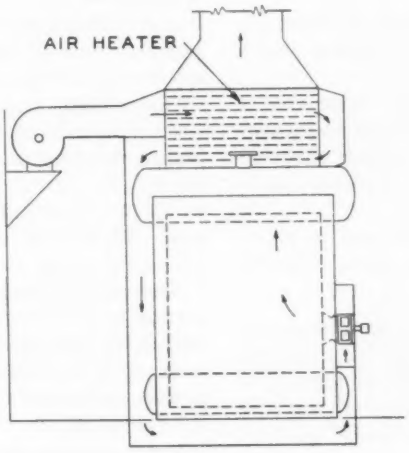


FIG. 16 FORCED DRAFT TO DOUBLE-CASED BOILER

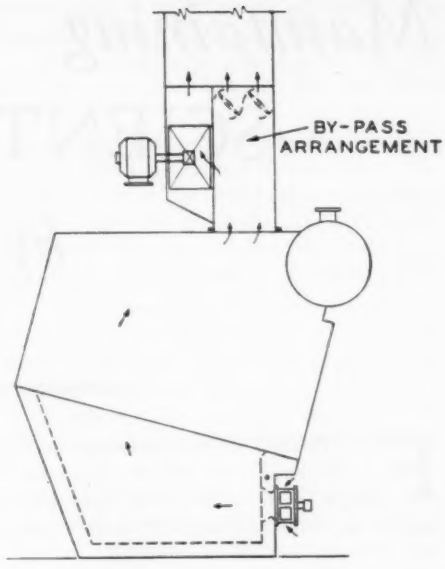


FIG. 17 INDUCED DRAFT

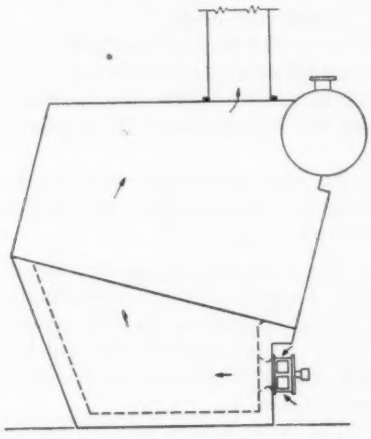


FIG. 18 NATURAL DRAFT

FUTURE TRENDS

What is the probable trend in fuels for shipboard use? Previous conceptions and customs are in many instances undergoing pronounced change, especially under the stimulus of the present emergency conditions. This tendency will probably continue in order to cope with keen competition after the war. It would not be surprising to find conventional hull arrangements modified to accommodate coal instead of oil. With any shortage of fuel oil and an accompanying increase in its price as compared to coal, the economics of which fuel should be used may easily be reversed, at the same time probably accelerating any tendencies for new arrangements in the hull. Likewise, equipment for handling coal into and out of storage and ash disposal will be adapted and improved so that coal may be stored in less valuable space and so that the handling equipment will compare more favorably as regards cost and bulk with that used for fuel oil.

In so far as the firing equipment itself is concerned, efforts will continue to obtain atomizers of wider range than those now available. Probably efforts will be made to modify the grates used with spreader stokers so that ash may be discharged continuously, thus eliminating any need for shifting boiler load when cleaning fires.

Maintaining SCIENTIFIC TOLERANCES *by* INSPECTION

By WILLIAM B. RICE

DEPARTMENT OF STATISTICS AND REPORTS, PLOMB TOOL COMPANY, LOS ANGELES, CALIF.

FOLLOWING in the footsteps of Shewhart (1),[1] Simon (2), Wilks (3), and others, the author suggested in a recent article (4) that design tolerances for manufactured products be determined from factual data, analyzed statistically as to:

(*a*) The characteristics required by users of the products.

(*b*) The characteristics of the manufacturing process by which the products are made.

When it has been determined that the process is capable of producing, at a satisfactory cost, a product which meets consumer requirements, the next problem is how to hold the process at the desired level. This is basically an inspection problem.

Before the manufacturer's inspection can succeed in maintaining the characteristics he wants in his product, three requirements must be met:

1 The manufacturer needs to know that his process can be depended upon, that no unpredictable changes occur during production, that he is actually producing what he intends to produce. These requirements can be met only with a statistically controlled process, as evidenced by the use of quality-control charts (5).

2 The manufacturer needs to know that his specifications are practical and profitable, that they will meet consumer demands at a profit to him. A method of meeting this requirement was suggested in the author's previous article (4).

3 The manufacturer needs to know that his inspection procedures are adequate, that from his inspection records he can draw sound and correct conclusions about that part of his product which he does not inspect, in order to be sure that the first and second requirements are being met.

This third requirement is the subject of the present article.

CONCEPTS INVOLVED

Before proceeding with the discussion it seems advisable to give a brief summary of the concepts involved in setting tolerances by statistical methods:

1 Recognition that all things vary and that variability can best be analyzed with statistical techniques. Tolerances should therefore be expressed in statistical terms, such as $\bar{X} \pm t\sigma$, rather than in absolute dimensions such as A, B.

2 Recognition that, in general, no tolerance limits can be set which will always include all pieces produced; that is, tolerances should be considered as probability limits, not absolute limits.

3 Recognition that tolerance limits vary in strictness, depending upon the seriousness of out-of-tolerance work, that more out-of-tolerance work can be permitted for minor defects than for major defects. In other words, specifications may be written $\bar{X} + t\sigma$, $\bar{X} - t'\sigma$, the value of t being different for each type of defect; larger for more serious than for less serious defects.

In the author's previous article (4), an illustration was given of the torque required for an open-end wrench; a "consumer" tolerance of 1500 in-lb, a process capable of holding 2100 in-lb and a design specification of 2000 in-lb, which the process was able to meet and which gave a $33\frac{1}{3}$ per cent margin of safety over the consumer requirement.

How should inspection be set up so as to be sure that the wrenches produced are satisfactory? Several possible methods present themselves. Torque tests could be made on every wrench, i.e., 100 per cent inspection; however, such inspection would be not only expensive but also inefficient because unnecessary. With a $33\frac{1}{3}$ per cent margin of safety, an occasional failure below the 2000-in-lb specification could be permitted.

Alternatively, sample torque tests could be performed. Assuming lots of 5000 wrenches, with 0.5 per cent defective permitted, the sample would have to be about 1000 pieces out of each lot (6). Such an inspection plan would still be quite expensive and would not give much information except to assure the desired quality level.

Yet another method would be to apply destructive torque tests to a small sample from each lot of 5000 wrenches, the torque being increased until the wrench broke. In this case the sample would have to be quite small for reasons of economy, so small in fact that sound judgments about the remaining wrenches could not be made on the basis of the single small sample.

CONTROL-CHART INSPECTION

All the objectionable features of the methods just proposed can be avoided, and practical certainty of a satisfactory product can be had by adapting the control-chart technique in somewhat the way used by Lieut. Col. Simon at the Aberdeen Proving Ground (2).

Five wrenches from each 1000 can be tested destructively and the readings recorded on control charts (5). As long as the process remains in "statistical control" at a satisfactory level (say, between 2100 and 2400 in-lb), only a small sample of 50 to 100 need be nondestructively tested for conformance to specifications in order to assure satisfactory outgoing quality.

Control charts can simplify and economize inspection procedures in this way because, with a "controlled" process, the manufacturer can be sure that his production methods are turning out a product with consistent characteristics, i.e., with only chance variations; he can be certain that no unknown or unexpected accidents are producing erratic and unpredictable results. Therefore, with this confidence and with the facts revealed by his control charts, he can safely depend upon a mere check test at final inspection.

The design specifications for this wrench should be so written as to provide for the correct inspection procedure. For instance, the upper tolerance limit could be omitted, but the

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

lower tolerance limit written in the form $\overline{X} - 3\sigma > 2000$ in-lb. The inspection specifications should call for control charts in approved form to insure meeting of specifications by the manufacturing process, and a torque check test of, say, 50 pieces out of each lot at final inspection to insure acceptable outgoing quality.

AN ASSEMBLY PROBLEM

A more complex situation arises when assemblies of two or more parts are involved. In the author's previous article (4), an illustration was given of an extension-and-socket assembly where the minimum clearance between the parts was required to be 0.004 in. and the maximum clearance 0.015 in. After analysis of the manufacturing process, design specifications were set up which called for female square (socket) tolerances of 0.515–0.511 in. and male square (extension) tolerances of 0.507–0.502 in.

The purpose of these tolerances was to make sure that the mechanics who used the tools would get a clearance above the maximum or below the minimum only about one time in a thousand assemblies. In other words, these tolerances were not absolute limits in the usual sense but probability limits. Totals of 3 per cent oversize and 3 per cent undersize parts were permitted by the specifications on each component; a probability of 0.03 on the female and of 0.03 on the male becomes $0.03 \times 0.03 = 0.001$ for the two parts when assembled.

The purpose of inspection here is not to assure a perfect product, but to assure an acceptable product; in this case not more than 3 per cent too large and 3 per cent too small. Detail or 100 per cent inspection is therefore not called for; some sampling scheme is more appropriate.

In deciding on the best sampling plan to use, two basic considerations should be kept in mind; (*a*) how to interpret the quality requirements implicit in the specifications; and (*b*) how to get the desired inspection results most economically.

As to interpretation, does the 3 per cent limit mean that no single lot worse than 3 per cent will ever be accepted? Or that only one lot in ten (or some other proportion) will be accepted if worse than 3 per cent? Or does it mean that over a long period of time the average quality must be not worse than 3 per cent?

In general, if the product is manufactured by a more or less continuous process, the long-term average interpretation may be used. Assuming an average lot size of 5000, a process average of 3.0 per cent and a desired long-term quality limit of 3 per cent, the Dodge-Romig tables[2] give the following sample sizes for most economical inspection cost:

Taking a single sample, inspect 210 pieces from each lot, allowing 10 or less defectives; detail all lots failing to pass the test. Taking a double sample, inspect 215 in the first sample, allowing 7 or less defectives; if more than 7 defectives are found in the first sample, inspect 390 more, allowing 27 defectives in all 605 pieces inspected. Detail all lots which fail the second sample.

Many other solutions of this problem are possible, depending upon the assumptions made and the theoretical approach used. For instance, if the process is known to be in a state of statistical control, the sample size and the cost of inspection may be greatly reduced. The Army Ordnance tables[3] recognize this fact.

If the sockets in this illustration are manufactured by an intermittent process, the lot-by-lot quality interpretation may be used. For the circumstances in this illustration the Dodge-Romig tables are not adapted, but other approaches are possible. Simon's I_Q charts (2) show that the desired protection can be obtained by accepting or rejecting on the basis of a sample size of approximately 130, allowing not more than one defect in the sample; only one lot in 10 will then be accepted with a quality worse than 3 per cent. Almost the same solution is offered by Working (7).

Neither of the interpretations so far discussed, nor any of the sampling plans proposed, are reasonable, however, because they set upper bounds of acceptability at the level of 3 per cent while by implication 3 per cent is expected to be the "average" quality produced by the process. That 3 per cent is the expected average quality is clear from the fact that the tolerance limits were set at $\overline{X} \pm 1.86\sigma$. If the frequency distributions were always exactly centered and exactly normal, exactly 3.14 . . . per cent of the pieces would fall outside on each tail of the curve. But the ideal conditions would never be met exactly—merely approximated over a period of time. A percentage of 3.14 therefore should be considered an average result rather than an extreme result.

The most satisfactory method of maintaining a desired average is by use of a control chart. Letting $\bar{p}$ be the process average actually obtained in manufacturing operations, and letting p' be the desired quality level, $\bar{p}$ should be equal to or less than p'.

In order to select the sample size desired, a practical criterion is to inspect a large enough number of pieces so that at least one defective will be found 9 times out of 10 in a 3 per cent defective lot. Simon's $0.9 = I_Q$ chart (2) can be used for this purpose, yielding 130 as the sample size. Control limits can then be set at

$$p' \pm 3\sqrt{\frac{p'(1-p')}{N}}$$

In the present sample, $p' = 3.0$ per cent, $N = 130$, and the limits are 7.5 per cent and 0 per cent. As long as the per cent defective falls below 7.5 per cent with a sample of 130, the product can be considered as acceptable, that is, as conforming to specifications.

It may be convenient, if a constant sample of 130 pieces is inspected from every lot presented, to convert these percentages to $p'n$ or acceptable number of defectives permitted in each sample. A percentage of 7.5 of 130 is 9.75, that is, the lot will be accepted if 9 or fewer defective pieces are found in the sample, rejected if 10 or more are found. In addition, a series of seven or more lots above the average 3 per cent level should be cause for suspicion that the process is not satisfactory; in this case $\bar{p}$ should be recalculated, and inspection tightened up. If at any time a point falls above the upper control limit of 7.5 per cent, detail inspection would be necessary and investigation should be undertaken at once to discover the cause of the bad work.

Since the lower limit is 0 per cent, no point can fall below it; but 7 or more consecutive points below the 3 per cent average could be taken to mean a probable improvement in the process and would warrant reduced inspection. An investigation should be made to determine the cause of improvement, with the aim of incorporating it as a permanent manufacturing procedure.

A further reduction in inspection should be permissible if 20 or more successive points are in control. In that case the Ordnance procedure could be followed. A sample size of 26 (one fifth as large as the regular sample) could be taken from each lot, provided (*a*) that the per cent defective in any reduced sample falls within control limits recalculated by the formula $p' \pm 3\sqrt{\frac{p'(1-p')}{N}}$, where N is 26; and (*b*) that the total number of defectives in any five small samples shall meet the requirements for any one large sample. In the present illustration with $p' = 3.0$ per cent, not more than 2 defectives would be

[2] Reference (6), Tables SA-3.0 and DA-3.0. Certain other assumptions, not mentioned here, are stated in the reference, which should be studied for further information.

[3] These are the tables used by the Ordnance Department, U. S. Army. They have not been published for general use.

permitted in any small sample of 26; and not more than a total of 9 in any five successive small samples.

Further refinements can be made in this type of inspection procedure, but perhaps the illustrations given will suffice to indicate one statistical approach to inspection problems. Much more could be said as to standards, gages, personnel, and other aspects of inspection, but these are less concerned with statistics than with engineering, design, and organization. But on the important matter of how much to inspect, statistical methods offer almost the only scientific solution.

It has been impossible to mention many of the basic implications of statistically designed inspection methods, i.e., randomness, consumer's risk, reliability, a priori and posteriori probability, and others. These are ably discussed in the various references, particularly by Dodge and Romig (6). Those who wish to pursue the subject further are advised to study the authorities carefully.

STATISTICAL SPECIFICATIONS

The application of "control-chart inspection" to statistically determined process and design specifications is graphically illustrated in Fig. 1. There a general grouping of all types of defects for any manufacturing process is proposed, with statistical, that is, probability, definitions of the critical, major and minor classifications. The suggested scheme is outlined and illustrated as follows:

Based upon facts gathered and interpreted as proposed in the author's previous article (4), the engineering department can set up scientific tolerances along the following lines:

Let S represent the design tolerances, and P_t the probability of a piece falling outside $\overline{X} \pm t\sigma$

If $\overline{X} = \dfrac{A + B}{2}$ and $t = \dfrac{A - B}{2}$, this becomes

$$S = \overline{X} \pm t\sigma.$$

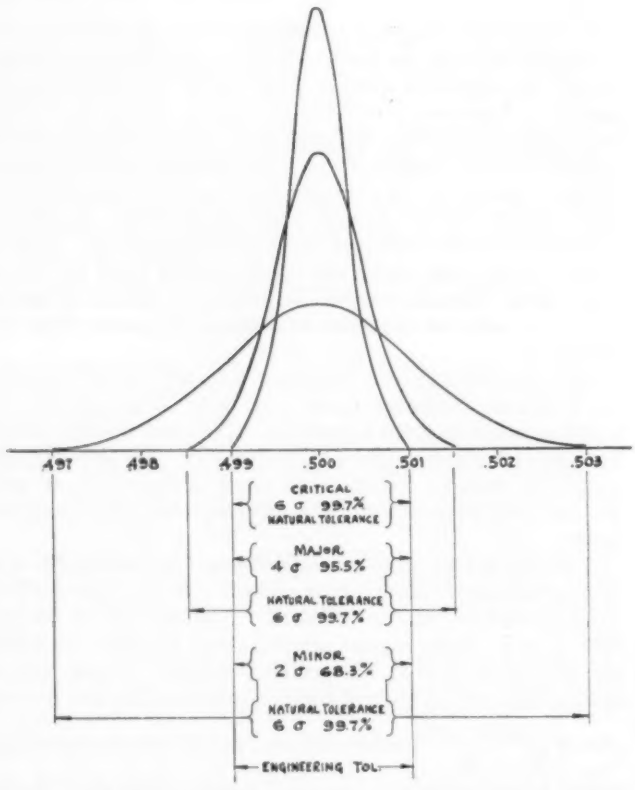


FIG. 1 RELATIONSHIP BETWEEN ENGINEERING AND NATURAL TOLERANCES FOR CRITICAL, AND MAJOR AND MINOR DEFECTS

Then, having as prerequisites (*a*) a statistically controlled process, and (*b*) a normal frequency distribution:

For a critical defect let $t = 3$ and $P_t = 0.003$ approximately
For a major defect let $t = 2$ and $P_t = 0.05$ approximately
For a minor defect let $t = 1$ and $P_t = 0.33$ approximately

As an illustration, suppose the tolerances were 0.501, 0.499. Then

$$\overline{X} = \frac{0.501 + 0.499}{2} = 0.500, \text{ and } t = \frac{0.501 - 0.499}{2} = 0.001$$

For a critical defect $t = 3$, therefore $3\sigma = 0.001$, and not more than 0.3 per cent out-of-tolerance pieces would be permitted.

For a major defect $t = 2$, therefore $2\sigma = 0.001$, and not more than 5 per cent out-of-tolerance pieces would be permitted.

For a minor defect $t = 1$, therefore $1\sigma = 0.001$, and not more than 33 per cent bad parts would be permitted.

Diagrammatically, Fig. 1 clarifies this approach to the problem.

In Fig. 1 the three curves illustrate the actual frequency distributions which would be typical of the three types of defects. The tall narrow curve is that which the process must produce if the defect is critical and blueprint tolerances are strictly adhered to. Similarly, the middle curve shows how much more leeway can be given production if the defect is a major one; and the low wide curve visualizes the process limits permissible for a minor defect. Note that the same gages and the same blueprint tolerances can be used for all three, simply by varying the percentage of out-of-tolerance work permitted.

In the socket and extension problem discussed, the tolerances were established at $\overline{X} \pm 1.86\sigma$, and 3 per cent out-of-tolerance pieces were permitted on each side of the curve. For purposes of standardization this could be modified to $\overline{X} \pm 2\sigma$, making it a major defect according to the definition proposed here, and allowing not more than $2^1/_2$ per cent to be too large and $2^1/_2$ per cent to be too small.[4]

Then at inspection the critical defects should require 100 per cent or detail inspection, the others, various degrees of sampling inspection. In each case inspection records kept in the form of control charts would give assurance that the process is satisfactory and that the required standard is being met. If the chart is not in control at a satisfactory level, action can be taken to improve the process, to revise specifications, or otherwise to get engineering, production, and inspection ideas to meet on common ground.

Such a meeting of minds will go far in bringing the members of the business team into harmony, all working toward a common goal. And this community of purpose will benefit labor, management, and investors alike.

[4] It will frequently be found in practice that one tolerance limit is critical, the other major or minor. The design and inspection problems involved in unequally spaced tolerance limits are, however, too extensive to be discussed in this article.

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AN ALL-YEAR GAS AIR-CONDITIONING UNIT

By H. C. PIERCE

GAS AIR CONDITIONING DIVISION, SERVEL, INC., EVANSVILLE, IND.

THE all-year air conditioner is a completely self-contained gas-actuated unit, designed to provide all the functions of complete year-round air conditioning. Heating, humidifying, air cleaning, and circulation in winter; cooling, dehumidifying, air cleaning, and circulation in summer are accomplished with one simple unit.

The chief component parts of the assembly are an indirect steam-heating system, an absorption refrigeration unit, an air-filtering section, and a centrifugal-fan section.

Gas is used as a fuel for winter operation and as a source of energy for summer operation. The unit contains a gas-fired boiler, or steam generator, which produces steam twelve months of the year. During the winter cycle, steam is delivered to a heating coil within the fan section of the unit assembly. During the summer cycle steam is delivered to the absorption refrigeration unit also contained within the unit assembly.

Any of the functions of complete air conditioning is available, by selection, through a co-ordinated control system. Temperature conditions are automatically maintained as desired.

The complete conditioner is compact and requires little space for installation. The height of all units is seven feet, depth four feet nine inches, and over-all width five feet three inches. The width at the base is two feet nine inches.

The first of these projected models will have a cooling capacity of three tons of refrigeration, coupled with a heating capacity of 120,000 Btu per hr. The other two models will have a refrigerating capacity of 5 tons each and heating capacities of 120,000 Btu and 180,000 Btu, respectively. Refrigerating ratings are based upon standard conditions of 75 F cooling water and an inlet air condition of 80 F dry-bulb and 67 F wet-bulb temperatures. Heating ratings indicated are in terms of gas input in British thermal units, the output being 80 per cent of these figures.

In addition to the three units mentioned, a 7.5-ton refrigeration unit, with balanced heating capacity, is also planned.

Complete control of the conditioner is centered in an instrument which is a combination of a thermostat and manually operated switches, which provides a modulated two-step automatic control to insure the proper heating or cooling capacity for varying conditions. It provides full capacity for peak demands of heating or cooling and partial capacity for moderate heating or cooling requirements.

Two switches are located on top of the thermostat. The right-hand switch has three labeled positions: "heating," "refrigeration," and "off." The left-hand switch provides for independent operation of the conditioner blower to permit air circulation during seasons when cooling or heating is not required. This switch is labeled "ventilation" and has "on" and "off" positions.

When it is desired to change the operation of the conditioner from the heating cycle to the cooling cycle or vice versa, the user resets the control switch on the thermostat, which is located at a convenient position in the space to be conditioned. When the switch is reset, a two-position steam diverter valve, (3) Fig. 1, automatically directs the flow of steam from the steam generator to either the heating coil or the absorption refrigeration unit.

The "ventilation" switch provides a selection of fan operation during the entire year. Normally, the fan of a summer air-conditioning system is run continuously and the room thermostat cycles the refrigeration unit only. Such an operation will result with this system when the "ventilation" switch is left in the "on" position, and the thermostatic dial is set at the proper temperature.

Normally, the fan of a forced-air heating system is only permitted to run when the burners are on, thus preventing the circulation of unheated air. Such an operation will result with this system when the "ventilation" switch is left in the "off" position. The fan then is under control of the thermostat and cycles with the gas burners. However, during the heating cycle a second control is permitted to function, namely, a fan delay switch in the form of an immersion type of aquastat. The bulb of this control is immersed into the header of the steam-heating coil and its action is such as to delay the start of the conditioner fan at the beginning of each "on" cycle of the burners until steam has been delivered to the heating coil.

The control system obviously contains other elements. However, these brief statements will serve to illustrate the basic functions and its latitude of selectivity.

AIR CYCLE THROUGH UNIT

Fig. 1 shows a cross-sectional view of the conditioner to illustrate the air cycle through the unit.

Inlet air to the conditioner enters a plenum chamber which contains filter elements (6). A large filter area has been provided which results in relatively low air velocities, producing desired high cleaning efficiency.

Air leaving the filter section passes through the cooling coil (7) which is a part of the absorption refrigeration cycle. During the summer period, heat is extracted from the air and moisture is condensed on the refrigerated-coil surface.

The air then passes through the heating coil (9). When the manual control switch is positioned to permit winter operation, the steam flow is directed automatically to the heating coil.

Air leaving the heating coil passes through the humidifier (10) which functions during the heating cycle. The humidifier consists of a number of horizontal trays, each equipped with an overflow tube which feeds water to the next lower tray. This arrangement provides a large evaporative surface. Water is supplied at a predetermined and controlled rate of flow to the humidifier trays.

The air is drawn through the unit by a centrifugal-type fan (11) which delivers the heated or cooled air through a duct distributing system to the various spaces being conditioned.

STEAM GENERATOR

Fig. 1 also illustrates the gas-fired steam generator or boiler (2) utilized for both the heating and refrigeration cycles.

The boiler, which is of cast iron, is compact. The water capacity, to the water line, is 75 lb for the 120,000-Btu boiler and 105 lb for the 180,000-Btu unit.

Contributed by the Process Industries Division and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Slightly abridged.

The gas burners (1) are of the conventional H-shaped, ribbon type. Four and six burners are used, respectively, on the two boiler sizes. A multiple burner arrangement was chosen to facilitate automatically controlled operation at either full or partial capacity. The burners cycle in accordance with the room thermostat during either winter or summer operation.

Steam at atmospheric pressure flows from the boiler into a two-position steam diverter valve (3) which automatically directs the flow of steam to either the heating coil or to the refrigeration unit. The valve is positioned by a damper motor which responds to the remote "heating" and "refrigeration" switch located remotely on the thermostat. Condensate returns from the heating coil to the boiler through the steam line.

COOLING WATER FOR REFRIGERATION UNIT

The refrigeration unit is water-cooled. The source of water can be from city main, a well, or a cooling tower. Selection is based upon water temperature and cost. When city water is used, a thermostatic water regulator valve is employed to modulate the flow of water to match the requirements of the refrigeration unit. The regulator valve is positioned in the leaving water side of the condenser and is set to maintain automatically a leaving temperature of 103 F regardless of temperature of inlet water.

In cases where city water temperatures are too high or cost of water is excessive, a cooling tower is recommended. Two induced-draft types of cooling towers have been developed as companion pieces to the 3- and 5-ton refrigeration units.

THE ABSORPTION REFRIGERATION CYCLE

Fig. 2 shows the refrigeration cycle in an arrangement which closely resembles its actual physical form. The over-all height of both the 3-ton and 5-ton refrigeration units is 7 ft.

As will be noted from Fig. 2, the refrigeration unit is made up of the following principal parts: Refrigeration generator; condenser; evaporator (cooling coil); absorber; and liquid heat exchanger.

All of these major parts and related accessories are factory-assembled as a hermetically sealed unit. To place the unit into operation is simply to connect a source of steam, provide cooling water for the condenser and absorber, and attach it to an air-distribution system.

Refrigeration is produced by the "absorption" principle and is a two-pressure type of system which utilizes heat in the form of steam as the motivating force. It should be early understood at the outset, however, that the entire cycle operates under a vacuum at all times. The absolute pressure within the generator and condenser, however, is somewhat higher than that in the evaporator and absorber. The pressure within the generator and condenser is approximately 1 psi absolute, whereas the absolute pressure within the evaporator and absorber is approximately 0.15 psi.

Simplicity of operation and control are the fundamental features which this type of system embodies. There are no moving parts within the refrigeration cycle.

The system is charged with lithium bromide and water, the lithium bromide being the absorbent and the water being the refrigerant. This solution is contained within the refrigeration generator.

The steam which boils the solution contained within the refrigeration generator is produced by a gas-fired boiler. This steam, at atmospheric pressure, is supplied through tube (1), Fig. 2, to the refrigeration generator, where it is condensed and flows by gravity to the condensate-return pump. Mechanical return of condensate to the boiler is required because the condensate outlet of the refrigeration generator is below the water line of the boiler.

The steam-generating system is so designed that fluctuations in pressure are not possible. A vent outlet from the steam chamber of the generator opens the steam circuit to the atmosphere. Steam does not normally reach the atmosphere through the vent outlet because its position is beyond the condensing load, which is the solution being boiled within the generator tubes. Most effective results are obtained when the heating medium for an absorption refrigeration cycle is at constant temperature. Such a constant temperature would not be available if pressure were permitted to fluctuate.

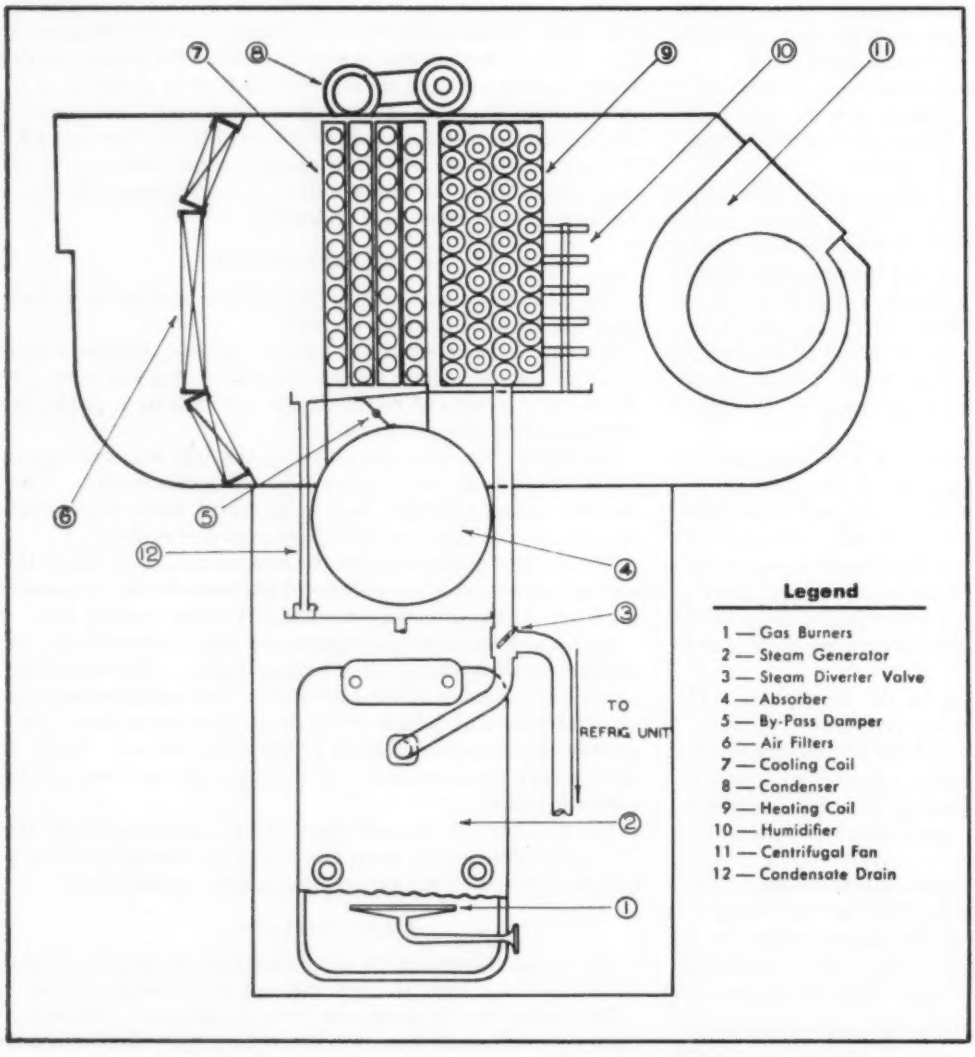

FIG. 1 SECTIONAL VIEW OF ALL-YEAR GAS AIR-CONDITIONING UNIT

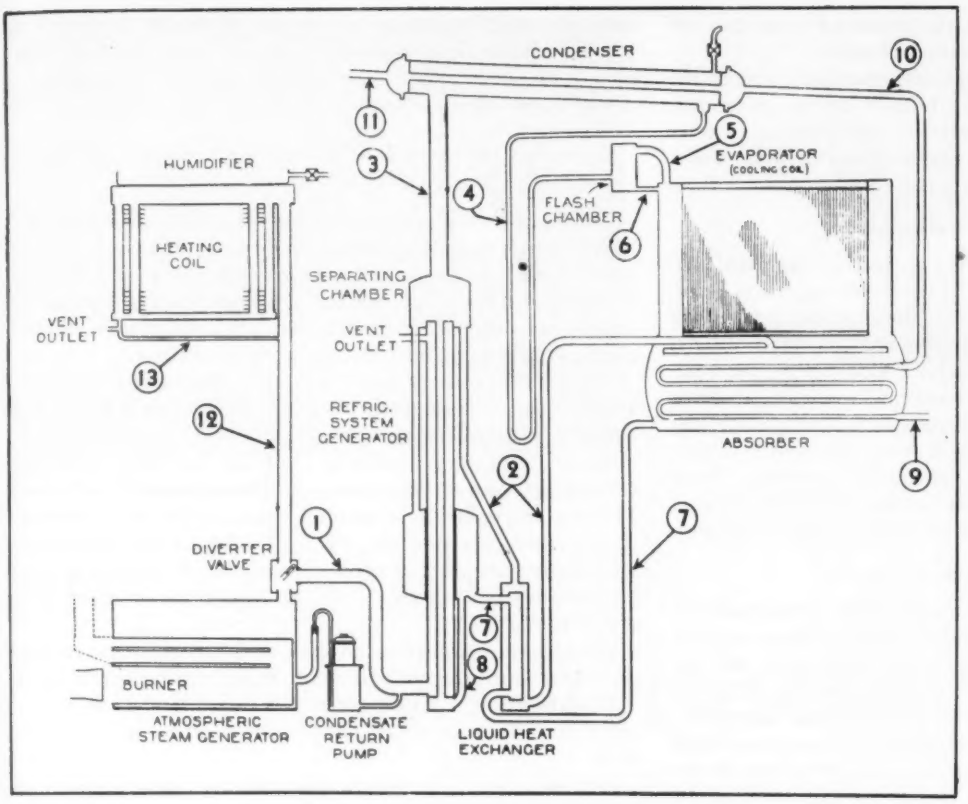

FIG. 2 REFRIGERATION AND HEATING CYCLE DIAGRAM

In this case the steam is at atmospheric pressure and the temperature is 212 F.

The generator is a cylindrical chamber containing a number of vertical tubes. Steam enters this chamber and heat is transmitted to the absorbent and refrigerant solution which is within each of the several tubes. A part of the refrigerant (water) is thus evaporated or boiled out of the solution. As this water vapor is driven off, absorbent solution is raised by vapor-lift action to the separating chamber above the generator.

Refrigerant and absorbent separate in the vapor separating chamber; the refrigerant as a vapor rises to the condenser through tube (3) and the separated absorbent as a solution flows down through tube (2) to the liquid heat exchanger and thence to the absorber. This circuit will be described more in detail later, as the refrigerant circuit will be discussed first.

REFRIGERANT CIRCUIT

The refrigerant (water vapor) enters the condenser where it is condensed to a liquid by cooling action of water flowing through the condenser tubes. The cooling water which flows through the condenser is brought from some external source, such as a cooling tower, city main, or well. The refrigerant then flows through the evaporator liquid inlet (4) which is a U-shaped tube. The U tube thus contains water at all times and maintains the pressure differential between the condenser and the evaporator.

The refrigerant (water) flows into a "flash" chamber ahead of the evaporator where part of it vaporizes owing to the lower absolute pressure (high vacuum) which exists at this point. The small amount of water which evaporates within this chamber lowers the temperature of the remainder to the evaporator temperature. The vapor thus formed passes out through a vapor outlet pipe (5) directly to the absorber. The water in the flash chamber goes through a tube (6) to the evaporator.

The evaporator contains finned horizontal tubes and the air being cooled flows horizontally through the coil.

The coil is built with five vertical banks of tubes in the direction of air flow.

The refrigerant (water) entering the top of the evaporator from the flash chamber passes into a distributing header which is designed to proportion the refrigerant with respect to the several tubes.

Refrigerant having been fed to the top tube of each vertical bank then progresses downward through all tubes in series. Evaporation of the refrigerant takes place within the tubes. The heat of evaporation for the refrigerant (water) is extracted from the air stream, and cooling and dehumidification is thereby accomplished. A high vacuum exists in the evaporator, which lowers the boiling point of water sufficiently to produce refrigeration.

In the absorber the solution absorbs the water vapors which were formed in the evaporator directly adjacent.

ABSORBENT CIRCUIT

To explain the presence of the absorbent at this point it is necessary to divert attention back to the generator and vapor separating chamber. As explained previously, the absorbent solution was separated from the refrigerant vapor in the separating chamber. This hot solution drains down through tube (2) to the liquid heat exchanger and then to the absorber. The function of the heat exchanger will be described later. The flow of solution in this circuit can actually exist by gravity action only because the absorber is slightly below the level of the separating chamber.

The absorber is a cylindrical shell which contains a coil through which cooling water is circulated. The absorbent solution flowing into the top of this chamber is distributed over the entire exterior surface of the absorber coil so that a maximum area of solution is exposed to the refrigerant vapor which is drawn into the absorber from the evaporator directly above.

It must be understood at this point that lithium bromide in either dry or solution form has a strong affinity for water vapor. It is because of this principle that the refrigerant vapor is absorbed into solution again. The rate of absorption is increased at lower temperatures, which is the reason for providing a water-cooling coil within the absorber shell.

The absorption process creates a slightly lower pressure in the absorber than in the evaporator, which causes the vapors being formed in the cooling coil to be drawn into the absorber.

The latent heat of vaporization liberated by the absorption of the refrigerant water vapors into the solution is dissipated into the cooling water flowing through the absorber coil.

The resultant mixture of refrigerant and absorbent collects in the bottom of the absorber and then drains back through tube (7) to the heat exchanger and then into a leveling chamber at the generator.

The leveling chamber normally is only partly full of solution which furnishes a reaction head for the generator system, so

that the water vapors formed in the generator tubes can lift the solution up to the vapor separating chamber.

The solution flows out of the leveling chamber through the generator inlet pipe (8) into the bottom of the generator. With constant heat source the solution continues to separate itself, by boiling action, into its two component parts, absorbent and refrigerant, thus repeating the cycle.

LIQUID HEAT EXCHANGER

The liquid heat exchanger serves to increase operating efficiency. The absorbent solution leaves the refrigeration generator at a relatively high temperature. Since its affinity for water vapor is increased as its temperature is reduced, precooling is desirable before it enters the absorber. Conversely, the combined solution of refrigerant and absorbent leaving the absorber and flowing toward the generator is relatively cool. Since heat is applied in the generator to drive off water vapor, it is desirable to preheat this liquid before it enters the generator. With counterflow action in the liquid heat exchanger, both precooling and preheating are accomplished within the solution circuit.

PRESSURE DIFFERENCES IN SYSTEM

As stated previously, a high vacuum exists throughout all circuits. However, a slightly higher absolute pressure exists in the generator and condenser than in the evaporator and absorber. This difference in pressure is maintained by difference in height of solution columns in the various connecting tubes.

The effect of heat applied to the refrigeration generator raises the solution to the vapor separator, located at the top of the generator, from which it is able to flow to the absorber by gravity, aided by the slight pressure differential between the two chambers. In the absorber, water vapor is taken into the solution, which then flows back to the bottom of the generator. Since the pressure in the absorber is slightly below that in the generator, solution flow from a low-pressure area to one of relatively higher pressure is accomplished by the action of the vapor lift.

The water vapor which was released from the generator rises to the condenser, where it is condensed to a liquid. Elevation of the condenser permits gravity flow of the refrigerant to the evaporator, aided by the slight pressure differential between the two chambers.

Thus by taking advantage of differences in fluid temperature, density, and height of columns, continuous movement in the same direction throughout all circuits is accomplished without moving parts.

COOLING-WATER CIRCUIT

The cooling-water circuit can be traced by noting that it enters the absorber coil at point (9). After the heat of absorption is picked up, flow is directed through tube (10) to the condenser and leaves the unit at point (11).

HEATING CYCLE

Fig. 2 also shows the heating-cycle diagram which may serve to clarify previous statements.

When the diverter valve is positioned automatically for heating operation, steam is directed into tube (12), thus serving the heating coil which is located within the fan section of the conditioner. Steam enters the upper horizontal header thus feeding the various vertical finned tubes. Three and four banks of vertical tubes are employed, dependent upon unit model and capacity.

With partial gas input only the upper half of the coil is filled with steam. With full gas input, about 80 to 90 per cent of the entire coil is filled. Under normal operating conditions steam never reaches the lower header and only condensate flows through tube (13). The condensate returns through the steam line (12) to the boiler.

The vent outlet from the condensate return line below the coil does not vent steam during normal operation because it is located beyond the condensing load. Because the cycle is not closed, pressure cannot exist within the steam generation and distribution circuits, therefore the heat source remains at 212 F.

APPROXIMATE PRESSURES AND TEMPERATURES FOR ASSUMED CONDITIONS

Temperatures and pressures within the refrigeration cycle will vary, depending upon operating conditions. The two variables encountered are condensing-water temperature and the heat load imposed on the evaporator by the air stream, but the operating pressure within the refrigeration cycle is below atmospheric at all times under all operating conditions.

Assume that cooling water is entering the conditioner at 85 F and that the inlet air condition to the evaporator is 80 dry-bulb and 67 F wet-bulb temperature.

Steam enters the generator at 212 F and surrounds the copper tubes which contain the solution of lithium bromide and water. The pressure, under the conditions stated, will be approximately 50 mm of mercury absolute. This particular solution will have a boiling temperature of approximately 165 F, so that the temperature difference between the steam and the solution being boiled is 47 F.

The absorbent solution and the water vapor passing through the vapor separator will, likewise, be at approximately 165 F.

The absorbent solution enters the liquid heat exchanger at 165 F and leaves at 108 to 110 F, a temperature drop of about 55 F.

Performance of the absorber depends to a large degree upon the temperature of the cooling water passing through the copper coil contained within. When cooling water at 85 F is supplied, the evaporator being loaded as previously stated, and absorbent solution enters at 108 to 110 F, the resultant pressure is approximately 9 to 10 mm of mercury absolute within the absorber shell. The cooling water is removing the "heat of absorption" resulting from the mixing of refrigerant vapor and absorbent and the water will leave the absorber and enter the condenser at about 93 F, a temperature rise of 8 deg. The temperature of the combined solution collected in the bottom of the absorber shell and draining down to the heat exchanger will be about 92 F or 93 F.

The pressure within the absorber establishes the pressure within the evaporator and will be practically identical. As water is the refrigerant employed, it follows that water is being boiled within the evaporator under a pressure of 9 or 10 mm of mercury absolute. The boiling temperature of water at this low absolute pressure is 50 F, and hence the refrigerant temperature within the coil is 50 F at this particular operating condition. For the purpose of comparison at this point, with a condensing-water temperature of 75 F, rather than 85 F, the refrigerant temperature within the coil would be 46 F.

Continuing with the typical example, using 85 F cooling water, let us examine the operation of the condenser. The condenser is of the single-pass type with multiple copper tubes. Refrigerant vapor enters the condenser at a temperature of 165 F and surrounds the copper tubes through which the cooling water is passing. Cooling water, entering the condenser at 93 F at the required rate of flow, will condense the refrigerant vapors and leave at a temperature of 100 F. Under these conditions the condensing temperature will be approximately 100 F, and the pressure about 50 mm of mercury absolute. The refrigerant will leave the condenser and flow through tube (4) to the flash chamber at a temperature of 98 to 100 F.

Another heat-transfer operation exists between refrigerant and air in the evaporator. When air to be conditioned enters the unit at 80 F dry-bulb and 67 F wet-bulb temperature and the inlet cooling-water temperature is 85 F the final dry-bulb air temperature is 60 F. Simultaneously with dry-bulb cooling,

(*Continued on page 189*)

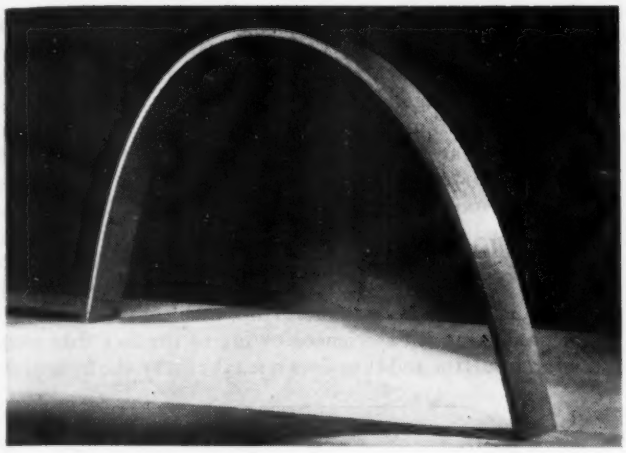

FIG. 1 PHENOLIC-LAMINATE FORMED SEALING RING

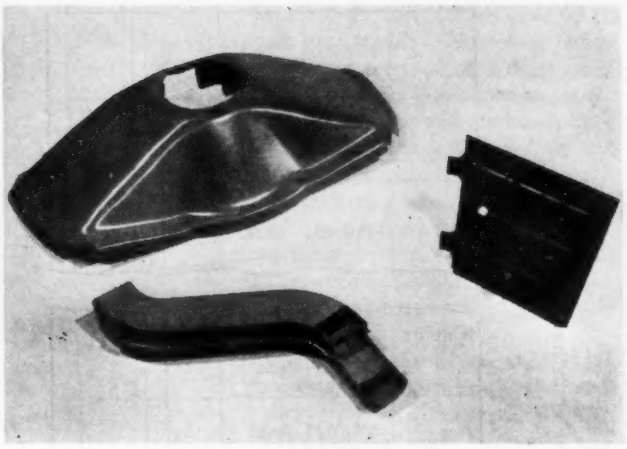

FIG. 2 AIRCRAFT HOPPER, DUCT, AND NAME-PLATE SUPPORT

HOT-FORMING *of* PHENOLIC LAMINATES

By H. C. GUHL

ENGINEERING MANAGER, MICARTA DEPARTMENT, WESTINGHOUSE ELECTRIC & MANUFACTURING CO., TRAFFORD, PA.

USERS of phenolic laminates have long felt the need for shaped parts made without the use of steel dies. In response to this demand, some early work was done by plastics engineers to shape parts with curved contours from premolded flat phenolic sheets. The shaping was done by taking the molded sheets, which had been given a predetermined cure, and then reheating them in an air oven to approximately 125 C, subsequently bending them over contoured wooden forms and leaving them clamped in this position until cooled to room temperature. In some cases, the shaped parts were returned to low-temperature ovens when in clamped positions in order to advance the phenolic resin somewhat further toward its finally cured state. One of these hot-formed laminates is shown in Fig. 1.

More recently, the aircraft-industry demand for hot-formed phenolic laminates[1] has been extremely vigorous. This demand has grown almost phenomenally because of (1) the broadening of available material supplies to meet the stress of war production, (2) the relatively good strength-weight ratio of phenolic laminates, (3) the flexibility in design which is permitted when low-cost and easily constructed tools are available, and (4) the convenience of stocking standard sheet materials at the point of aircraft manufacture, which may be readily converted into parts. Typical applications of hot-formed phenolic laminates for aircraft parts are shown in Figs. 2 and 16

TYPES OF PHENOLIC LAMINATES

The basic types of phenolic laminates are quite well defined[2] and the generally known N.E.M.A. grade C material had been accepted as the most desirable type for hot-forming work. The reasons for this are (1) the base cotton fabric and the resin binder are balanced to provide maximum toughness, good structural properties, and reasonable moisture resistance; and (2) the best formability that is available in this type of phenolic laminate. However, other types of laminates might be suggested which would exhibit far greater formability, as, for instance, thermoplastic-resin laminates, but these have been found to be somewhat undesirable, because of their cold-brittleness and heat-softness characteristics. Paper-base phenolic laminates have also been considered for formed parts. However, their formability is very limited because of the relative shortness of paper fiber as compared to woven fabric threads, and the inherent mechanical make-up of paper laminates. Other thermosetting-type resin laminates, such as melamine and urea, may also be made to provide a certain amount of hot formability, but because of their generally harder and more brittle characteristics, their reshaping is somewhat limited.

Even though the grade C type phenolic laminate was accepted as the most desirable one for hot-forming, it nevertheless left much to be desired if hot-forming was to become widely successful. Resins were thus modified and base fabrics adjusted so that highly formable laminates became available, which as laminates still provided the essential properties of grade C material.

RESIN CHARACTERISTICS

It is generally known that formation of phenolic resins from the initial raw ingredients to the final cured state is evidenced by increasing viscosity which is defined chemically as polymerization. The rate of change of the resin from its initial soluble state to its final "set" state has been a means of manufacturing control by resin chemists. These chemists had noted that even in the set state the resin exhibited a certain amount of pliability at elevated temperatures. This pliability characteristic has been found to be a means toward reshaping the resin at elevated temperatures even when in its normally cured state.

[1] "Thermoelastic Forming of Airplane Parts," by W. I. Beach, MECHANICAL ENGINEERING, vol. 65, 1943, pp. 719–723.

[2] N.E.M.A. Laminated Phenolic Products Standards, Publication No. 39–57, 1939.

Contributed by the Rubber and Plastics Division and presented at the Semi-Annual Meeting, Pittsburgh, Pa., June 19–22, 1944, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

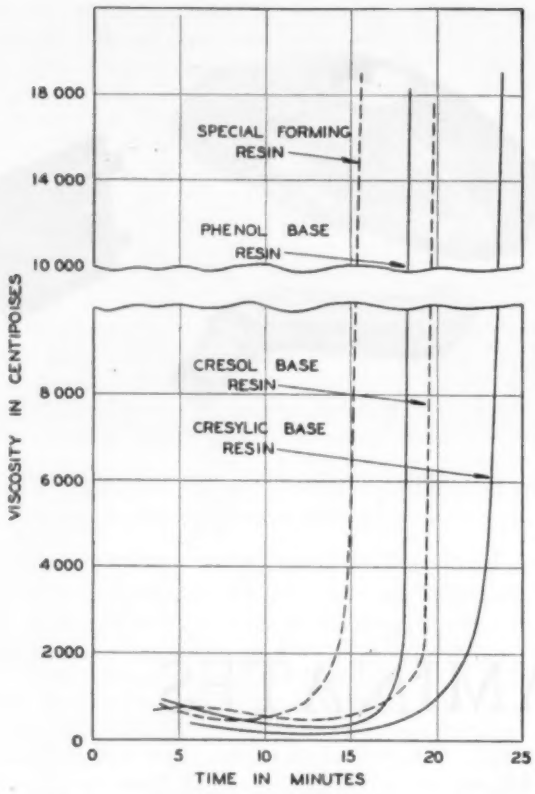

FIG. 3 VISCOSITY CHARACTERISTICS OF PHENOLIC RESINS

Typical time-viscosity curves for several phenolic laminating resins are shown in Fig. 3.

Fabric Characteristics. As already indicated, a great deal of latitude is available in the selection of fabrics, but suffice to say here that it should be one having reasonable elongation from crimp and stretch in the individual yarns with a good measure of tensile strength provided. Fabrics of balanced weave will provide best uniformity in all directions, but considerably greater formability may often be had with nonbalanced fabrics, and proper selection of "grain" is made to suit the intricacy of the parts to be formed.

Heat-Distortion Properties of Laminates. The hot-forming of laminates naturally implies some distortion at elevated temperatures in order to secure formability. However, it is necessary to secure such properties that distortion at working temperatures under load is nil, in order to obtain serviceability. Fig. 4 shows heat-distortion properties of several laminates when tested by A.S.T.M. Method D641-41T. Fig. 5 shows hardness properties of these same laminates when tested by A.S.T.M. Method D634-41T. Other properties are shown in Figs. 6, 7, and 8. General physical properties are given in Table 1. Properties compared to other standard materials are given in Table 2.

FORMING PROCEDURE

For forming, it is desirable to heat the laminate in order to bring it to optimum forming temperature as rapidly as possible. The purpose of this is to make use of the maximum pliability still available in the resin and also to minimize embrittlement by oxidation. Various sources of heat may be used, such as hot plates, high frequency, infrared lamps, hot-air ovens, or hot liquid baths. Rate-of-heating curves are shown in Figs. 9, 10, and 11. For best formability, the material should be heated to 300–350 F temperature, and the maximum temperature allowable may be determined by noting the blister point of the material at hand.

Forming Dies and Their Construction. A number of satisfactory materials are at the disposal of design engineers for use in die construction. High-strength metals may be employed if desirable from the standpoint of maximum durability in production, but this is generally unnecessary and fails to take into account the special advantage of hot-formed phenolics in that low cost and readily shaped materials are adaptable. Most hot-forming can be handled at pressures of 50 to 100 psi, and even softwoods could accommodate this loading for a limited number of pressings. Hardwoods, however, can be shaped nearly as readily as softwoods and these offer highly acceptable materials for the forming dies. During the forming operation, it is necessary to "fix" the shaped laminated part into its final contour while cooling, and if so held by the form die, then considerable slowing of production is experienced owing to the fact that wood acts as an insulator and thus does not take away the heat of the

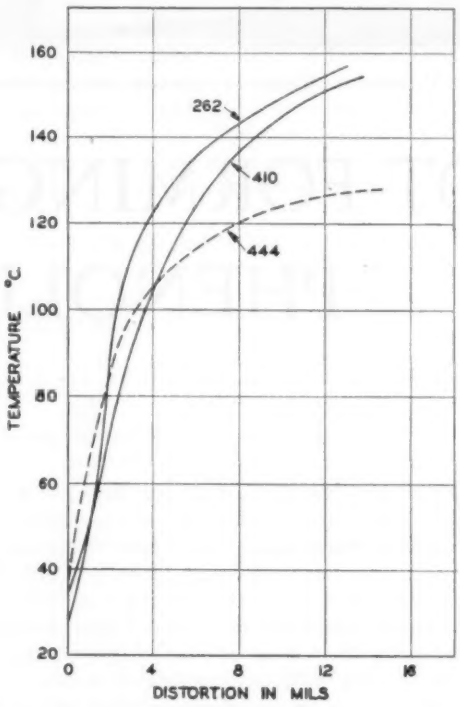

FIG. 4 HEAT-DISTORTION CURVES OF LAMINATES

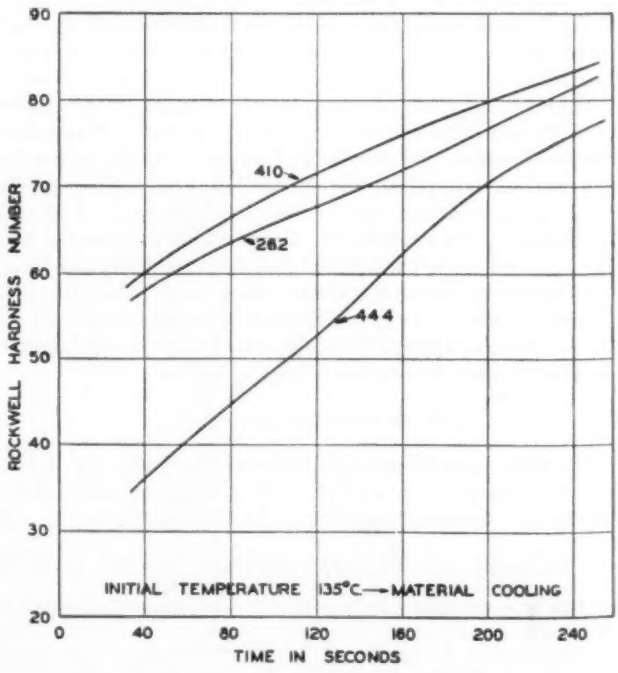

FIG. 5 HARDNESS CURVES OF LAMINATES

TABLE 1 PHYSICAL PROPERTIES OF LAMINATES

	Formable —Micarta 444—		Semiformable —Micarta 410—		N.E.M.A. Grade C —Micarta 262—	
	With grain	Cross grain	With grain	Cross grain	With grain	Cross grain
Tensile strength, psi....	13000	11000	13000	11000	13000	9000
Modulus of elasticity in tension, psi.....	0.9×10^6	0.9×10^6	1.1×10^6	1.0×10^6	1×10^6	0.8×10^6
Flexural strength, psi:						
Flatwise.....	19000	16000	24000	18000	20000	20000
Edgewise.....	19000	16000	24000	18000	20000	20000
Impact strength (Izod), ft-lb per 1 in. of width on notch:						
Flatwise.....	2.9	2.3	6.0	5.0	6.5	4.5
Edgewise.....	1.3	0.7	3.0	2.0	4.0	2.5
Compressive strength, psi:						
Flatwise.....	30000	30000	37000	37000	40000	40000
Edgewise.....	16000	16000	20000	20000	23000	23000
Bond strength (load in lb—Specimen 1 in. × 1 in. × 1/2 in.).....	1600		2100		1800	
Dielectric strength, volts per mil:						
Short time.....	240		200		250	
Step by step.....	130		100		140	
Specific gravity.....	1.37		1.39		1.38	
Water absorption, per cent weight gain in 24 hr:						
3 in. × 1 in. × 1/16 in.	4.5		4.5		4.5	
3 in. × 1 in. × 1/8 in.	2.5		2.6		2.5	
Thermal conductivity (cal/sec/deg C/sq cm/cm).....	Approx 0.00061		Approx 0.00061		Approx. 0.00057	
Specific heat.....	Approx. 0.4		Approx 0.4		Approx 0.4	
Thermal coef. of expansion (per deg C).....	Approx. 31 × 10^{-6}		Approx 31 × 10^{-6}		Approx 36 × 10^{-6}	
Color	Tan		Green		Tan	

part nor in turn does it give up its own heat readily. Therefore, when wood dies are used, it is often desirable to provide jigs and fixtures for holding the shape of the hot-formed part while being removed from the forming die, and the fixed part is then immersed in cold water.

Other materials suitable for forming-die construction are low-melting alloys such as Kirksite, plastics, particularly thermosetting types, or high-strength concrete.

For hot-forming phenolic laminates, it has generally been found, however, that die materials which have some resiliency ("give") provides the most satisfactory performance. Equalization of presures is thus somewhat accomplished without high accuracy in the die surfaces.

Several typical die constructions are shown in Figs. 12, 13, and 14.

DRAWN SHAPES

Deep-drawing properties of forming laminates have been developed which approach those of soft aluminum. To determine the limits of draw, a test apparatus, as shown in Fig. 15, was employed. The shape of the drawn piece could be selected

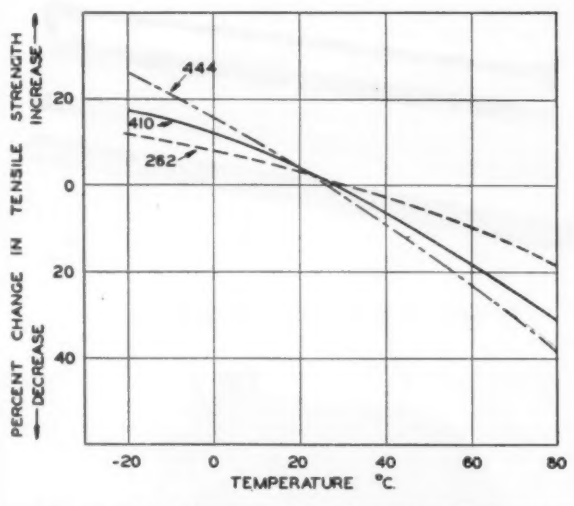

FIG. 6 THERMAL EFFECTS ON ULTIMATE TENSILE STRENGTH

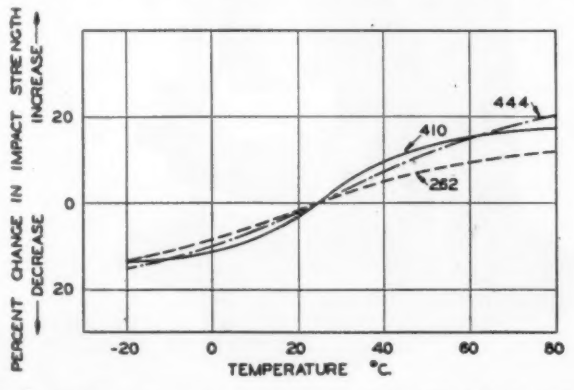

FIG. 8 THERMAL EFFECTS ON IMPACT-STRENGTH FORCE APPLIED EDGEWISE

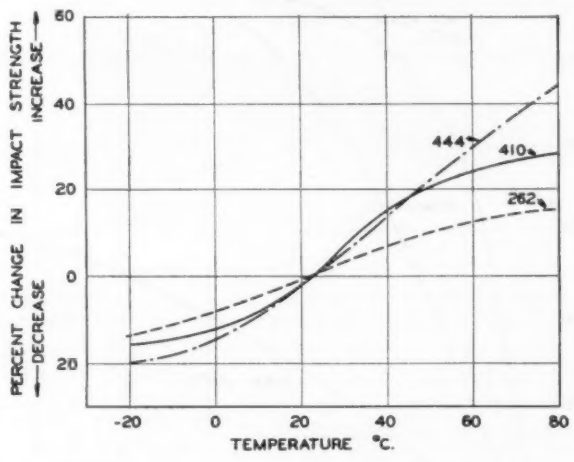

FIG. 7 THERMAL EFFECTS ON IMPACT-STRENGTH FORCE APPLIED FLATWISE

as (1) the cylindrical flat-bottom cup; or (2) the spherical-bottom cup, according to the selection of the punch. In all cases during the forming operation, the hold-down pressure on the draw ring was adjusted to a minimum which was required on the blank to prevent wrinkling. Excessive hold-down pressure could produce premature failure before maximum draw was obtained.

As in the case of drawing investigations of metals,[3] the ratio of cup radius r to blank radius R could be applied mathematically for calculating the index of formability. When the limiting value of R is used, the ratio r/R indicates the maximum depth to which the part can be formed. It has also been found that the final area of the drawn part is approximately equal to

[3] "Drawn Cylindrical Shapes of Various Aluminum Alloys," by Thomas H. Hazlett, *Product Engineering*, vol. 14, 1943, pp. 425–428.

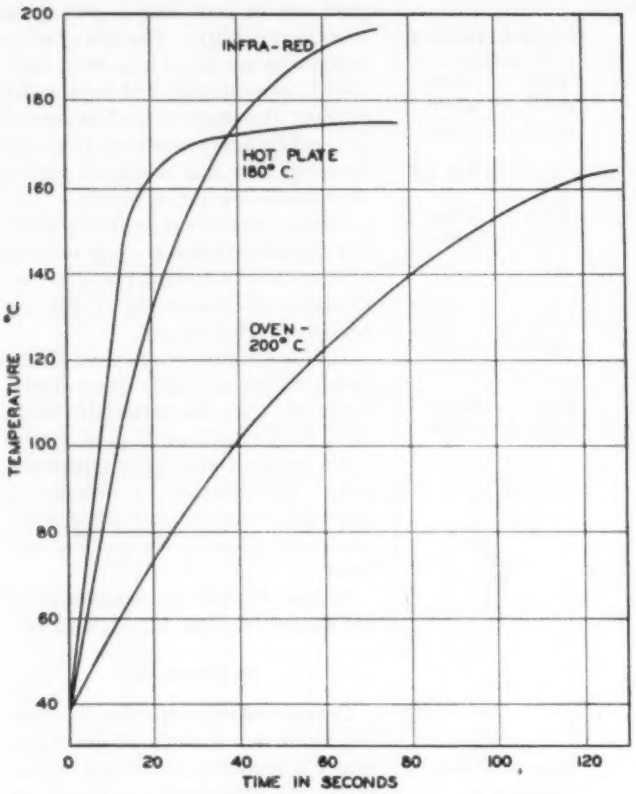

FIG. 9 RATE OF HEATING $^1/_{16}$-IN-THICK LAMINATE

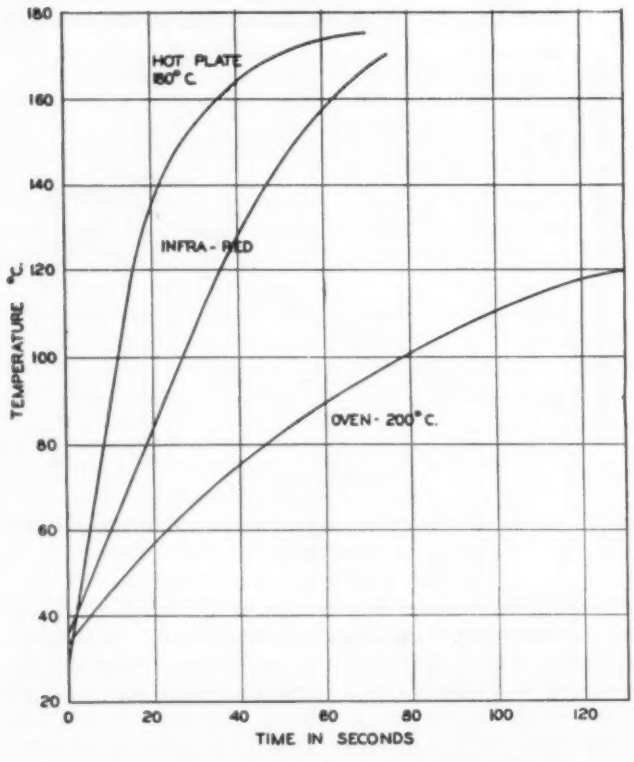

FIG. 10 RATE OF HEATING $^1/_8$-IN-THICK LAMINATE

the area of the initial blank for cylindrical flat-bottom cup drawn parts with very small corner radius; and then h, the depth of draw, is equal to $\frac{R^2 - r^2}{2r}$. The value of the index of formability, r/R, has been found to be from 0.67 to 0.77 for good hot-drawing laminated phenolic sheet in thicknesses from $^1/_{32}$ to $^1/_{16}$ in.

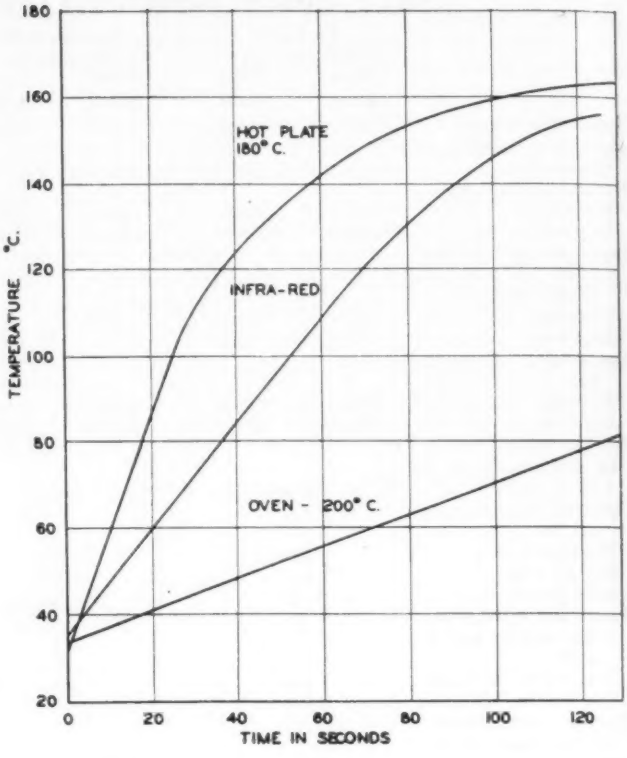

FIG. 11 RATE OF HEATING $^1/_4$-IN-THICK LAMINATE

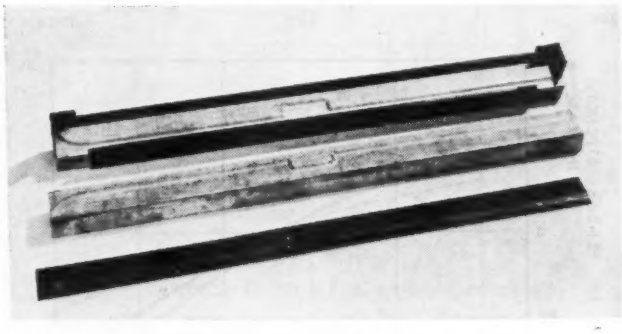

FIG. 12 COMPRESSION FORMING DIE

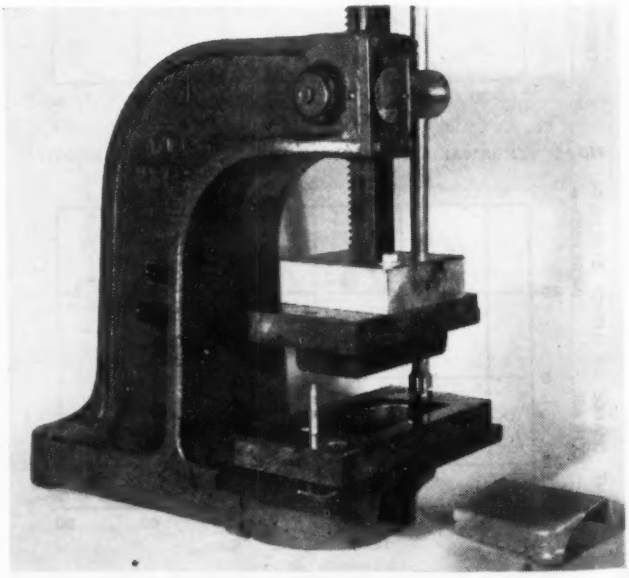

FIG. 13 CHANNEL-FORMING DIE AND PRESS

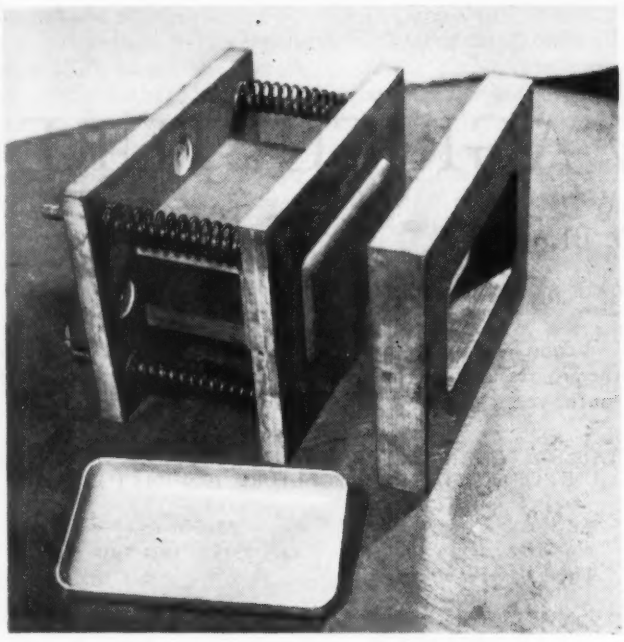

FIG. 14 COVER DRAWING DIE

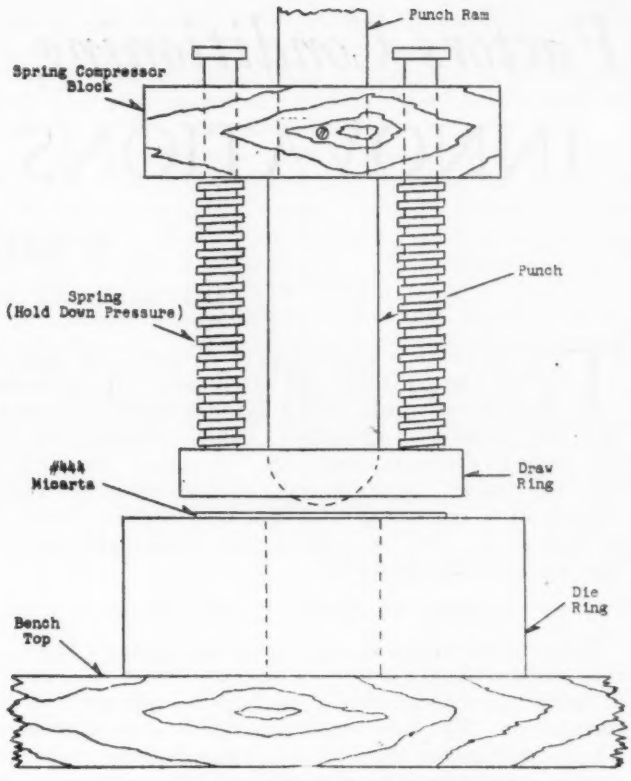

FIG. 15 DRAWING-TEST APPARATUS

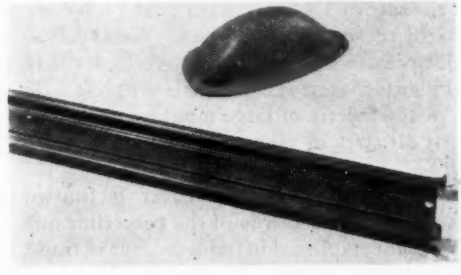

FIG. 16 AIRCRAFT-AMMUNITION-HANDLING PARTS

Drawn box shapes may be similarly considered,[4] but a great deal of care and judgment must be exercised when applying material in practice. Until more accurate design data can be developed, it is necessary that only those designs which may be considered "safe" be adapted to deep-drawn box shapes.

Die clearances are especially important factors in forming deep-drawn parts. The fits between punch and die should be sufficiently tight so that the proper ironing action takes place. A clearance of 0.010 in. above the thickness of the material is considered desirable. In corners, the clearance, however, may be somewhat greater to allow for some flow of material without development of excessive friction which may cause failures.

[4] "Drawn Box Shapes of Various Aluminum Alloys," by Thomas H. Hazlett, *Product Engineering*, vol. 14, 1943, pp. 517–519.

TABLE 2 PHYSICAL PROPERTIES OF MICARTA, WOODS, AND METALS

Material	Specific gravity	Tensile strength, psi	Ratio of tensile strength to specific gravity, psi	Compressive strength, psi	Ratio of compressive strength to specific gravity, psi	Modulus of elasticity in tension, psi	Modulus of elasticity in compression, psi
Hot-forming Micarta 444	1.37	13000	9450	33000	24100	0.9×10^6	0.55×10^6
N.E.M.A. Grade X Micarta 213 Army I-X Navy PBM	1.35	16000	11800	38000	28100	1.7×10^6	0.83×10^6
N.E.M.A. Grade C Micarta 262 Army II-C Navy FBM	1.38	11000	8000	35000	25400	1.05×10^6	0.56×10^6
Aircraft spruce (Douglas fir)	0.43	10000	23300	5000	11600	1.3×10^6	1.3×10^6
Birch plywood	0.80	13100	16400	5700	7100	1.4×10^6	1.3×10^6
Stainless steel (18-8)	7.85	185000	23600	150000[a]	19100	30×10^6	30×10^6
Aluminum alloy (24S-T.)	2.80	62000	22100	40000[a]	14300	10.4×10^6	10.4×10^6
Magnesium alloy (Am-585)	1.81	46000	25400	35000[b]	19300	6.5×10^6	6.5×10^6

[a] Yield point in compression.
[b] Yield point in tension.
NOTE: Yield point in compression is substantially equal to yield point in tension in wrought alloys.

Fitting of the die during initial trials has been found to be a very practical way in setting up new operations. Lubrication of the die during forming operations is essential in securing satisfactory production.

Presses for operating the dies may be mechanically, hydraulically, or pneumatically operated types as determined most convenient for the operations required. Suffice to say here that generally fast-operating presses will contribute to the success of hot-forming phenolic laminates.

The data presented in this paper are intended primarily to guide designers and users in making application of these newly developed formable phenolic laminates. Fields of application are expanding rapidly and new and improved handling techniques will come into use. It is hoped these will appear in future publications.

Factors Conditioning INNOVATIONS *in* AGRICULTURE

By JOHN D. BLACK

HENRY LEE PROFESSOR OF ECONOMICS, HARVARD UNIVERSITY

THAT to invent a new device, or develop a new method, and then to get it used, are two different steps in human progress, oftentimes with a long lag between, is not an experience peculiar to agriculture. Social scientists often use two terms to designate these steps, "invention" for the first, and "innovation" for the second. The process of innovation is particularly interesting to observe in agriculture because of its gradualness. One has a chance to observe it, as it were, in slow motion in agriculture.

OUTPUT PER WORKER IN AGRICULTURE

The common opinion among professional engineers, however, that productivity per worker has increased much more slowly in agriculture than in industry, needs to be examined with circumspection. The difference is not as great as often assumed. The best evidence on the subject is to the effect that output per worker in agriculture, between 1869 and 1937, increased at the rate of 2.1 per cent per year, and in manufacturing in the same period at the rate of 3.9 per cent per year.[1] We are all deceived by reports of the exceptional cases. Great advances in some large-scale operations have made us overlook the large numbers of smaller plants that have made little progress. The statistical principle of the inertia of large numbers appears in the case of industry, if all sizes of plants are included, even as it does in agriculture.

The comparison ought not, moreover, be limited to industry and agriculture. Two thirds of the peacetime nonagricultural labor force is not employed in industry, but in trade, transportation, construction, mining, lumbering, domestic and professional service, and the public service. There is no way of reucing the output of many of these activities to a physical-volume basis. The "service" that we get out of a day's work spent in merchandising in 1937, or in professional entertainment, or housework, cannot be compared very accurately with its nearest equivalent in 1869, by dividing the aggregate payment for it by the rate of wages and salaries. But in so far as it can be measured in this way, it would appear that the increase in output per worker was only 1.1 per cent per year for all nonagricultural labor. This means that in some lines of activity the gain must have been very little, perhaps only 1 or 2 per cent in 10 years. Most of us are aware that effort in many merchandising lines has more largely gone into competitive selling rather than into increasing the output of services.[2]

A conscientious attempt was made some years ago to measure the progress in different lines of agricultural production, mostly for the years 1934–1936 as compared with 1903–1913.[3] Table 1 presents examples of the results obtained, in terms of man-hours of labor. These are national averages in most cases. If the regions of highest concentration of production are considered by themselves, usually the gains are greater, for example, 57 per cent for wheat in the small grain areas, and 60 per cent in the range states.

TABLE 1 CHANGES IN LABOR INPUTS PER ACRE AND PER UNIT OF OUTPUT IN AGRICULTURE, 1909–1913 TO 1934–1936

Product	Unit	Man-hours 1909–1913	Man-hours 1934–1936	Percentage change
Wheat	Per acre	12.7	6.1	−51
	Per bushel	0.89	0.41	−54
Corn	Per acre	28.7	22.5[a]	−22
	Per bushel	1.09	0.90[a]	−17
Potatoes	Per acre	86	76	−12
	Per bushel	0.79	0.66	−16
Oats	Per acre	12.5	7.9	−37
	Per bushel	0.42	0.27	−36
Cotton	Per acre	105[b]	88	−16
	Per bale	271[b]	218	−20
Sugar beets	Per acre	113[c]	94	−17
	Per ton	11.2	8.7	−22
Dairy	Per cow	135	140[a]	+ 4
	Per 1000 lb of milk	35.5	33.0[a]	− 7
Poultry	Per 1000 eggs	30.6	26.0[a]	−15

[a] 1932–1936 instead of 1934–1936.
[b] 1907 instead of 1909–1913.
[c] 1913–1917 instead of 1909–1913.

The National Bureau of Economic Research has undertaken to bring these data and others together and arrive at composite rates of increase in output that it can compare with the rates it has computed for manufacturing industries.[4] The final estimates by 10-year intervals are given in Table 2. The figures for each year are averages of 3 to 5 years centered on this year, omitting years abnormally high or low because of business booms or depressions. The first column for agriculture includes the

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[1] "Parity, Parity, Parity," by J. D. Black, Harvard Committee on Research in the Social Sciences, 1941, pp. 79–80. These rates were obtained by dividing indexes of the physical volume of production by the number of workers employed in each, including farm produce consumed by the farm families as part of agricultural output, and making allowance for part-time employment of farmers in industry.

[2] Some agriculturists are disposed to counter the allegations of slow progress by pointing out that only one worker in four or five was employed in producing food and fiber in 1939-1940, as compared with one in two after the Civil War. Exports of food and fibers have declined in these years, but not enough to affect the comparison much. But this shift in the proportion of food producers has other explanations; i. e., some of the labor force in cities is now employed in producing, distributing, and servicing the additional farm machinery, the automobiles, the gasoline, and the fertilizer, lumber, and other supplies now being used in farm production; some of it even in manufacturing and selling the additional processed foods, clothing, and house furnishings now being used by farm families. The other explanation is that the population is spending a much smaller fraction of its income for food now than earlier. This percentage for 1939–1940, was 21.5 and for 1909–1910, probably around 30 per cent. A guess for 1869 would be 40 per cent. (See *Agricultural Outlook Charts*, 1944, p. 17.)

[3] This was a special project financed by the Work Projects Administration, conducted under the general direction of Prof. John A. Hopkins of Iowa State College. The results were published in a series of reports bearing such titles as: "Changes in Technology and Labor Requirements in Crop Production: Cotton;" "Trends in Size and Production of the Aggregate Farm Enterprise, 1909–1936;" "Changes in Farm Power and Equipment: Mechanical Cotton Pickers;" "Tractors, Trucks, and Automobiles: Field Implements."

[4] See Solomon Fabricant, "The Output of Manufacturing Activities, 1899–1937," and "Employment in Manufacturing Activities, 1899–1939" (p. 331 especially); also "American Agriculture, 1899–1939: A Study of Output, Employment, and Productivity," by Harold Barger and Hans H. Landberg (pp. 251–253 especially). Published by the National Bureau of Economic Research, New York, N. Y., in 1940 and 1942.

women and children who help with the farm work, mostly on a part-time basis. The decline in numbers of these, especially since 1920, makes the increase in output per worker appear altogether too high. On the other hand, computing output per number of adult males only, as in the last column, makes the increase appear too small. Probably a figure of around 170 would be about right for 1940. This would mean a gain of 17 to 18 per decade, as compared with 21 for the whole period since 1869. The increase was small from 1900 to 1920. All of the gain in the 1930's was in the last 3 years. The comparable gains in manufacturing in 1900–1940 were 27 to 28 per decade as compared with 39 over the whole period since 1869. The slowing up in the 1900–1920 years is apparent in manufacturing also. In the 1920–1930 decade, manufacturing gained 50 and agriculture probably around 25.

TABLE 2 OUTPUT PER WORKER IN ALL MANUFACTURING AND ALL AGRICULTURE, 1900 TO 1940[a]

		Agriculture	
	Manufacturing	All agricultural workers	Males 20 years old and over
1900	100	100	100
1910	112	109	103
1920	131	120	112
1930	181	151	132
1940	210	190	154

[a] 1900 = 100.

INCOME AND DEMAND AS A FACTOR

The principal object of this paper, however, is to account for the relatively slow progress of innovation in agriculture rather than to measure the amount of it. Why has it not proceeded faster?

The first reason to be considered is the retarding effect of inadequate demand and low farm prices much of the time. From 1920 to 1939, the agricultural output of this country increased only a little over 1 per cent a year; 25 per cent in 20 years. That it would have expanded at double this rate with good demand is obvious from the fact that it has gained at least another 25 per cent in the last 4 years, and has done this in spite of shortages of machinery, fertilizer, and other supplies, and while losing 1,500,000 of its most able-bodied workers to the armed forces, and more than 3,000,000 to war plants and other nonfarming occupations.

Back before 1896, was another period when farm products were pressing strongly on their markets, largely because of the spread of farming over the great plains. Only in the intervening period from 1898 to 1920, was the world demand for food pressing on the supply. In these years, prices of farm products rose considerably faster than the general price level, and also faster than industrial wages. So quick was the production response to this unusual situation that the turn probably would have come in 1916-1917 except for the first world war and some poor crops.

Nor is pressure of food supplies on the market only a phenomenon of the past. Unless more vigorous measures are adopted than ever before, the expansion that has taken place in this country since 1939, and in the other food- and fiber-exporting countries at the same time, will surely create new agricultural surplus situations within 2 or 3 years after the end of this war. This will happen even with high-level employment in the cities. With low-level employment, the surpluses will be the largest this country has ever known.

Some object to the use of the term surplus in this connection. They say that there would be no excess production if everybody had enough to eat. They are of course trying to give the term surplus a new definition. The standard meaning of it is a stock of goods that does not move through the existing markets into consumption. Our farm products did not move through the markets in the 1930's even at the low prices prevailing. They will not again in 1947–1950. Particularly will they not move at the prices which the Farm Bloc thinks are just and fair.

A combination of three types of measures will be needed to keep farm products moving through the markets in 1947 and afterward. These are as follows:

1 Shifting some production of foods for direct human consumption (wheat, rye, rice, beans, potatoes, and cotton) to dairy products, eggs, and meats. Livestock products use much more land and labor per calorie and per pound of protein than cereals; roughly 10 times as much. Shifting 40,000,000 acres in this way will probably be enough.

2 Expanding home consumption of food, especially of livestock products, by means of school lunches, the stamp plan, etc., as well as by education and propaganda.

3 Developing exchange arrangements under which we can sell abroad some of the products that we can produce cheaply with power and machinery on our broad acres—wheat, rice, lard, dry peas and beans, and probably soybeans. Cotton could come in this group also if the Cotton Bloc would let it.

A fourth measure would help considerably, i.e., to let the prices of the different farm products get into better relations with one another and with cost-demand relations. A fifth may be necessary, especially if we have a good bit of unemployment, i.e., to let the general level of prices of farm products subside a little further below "parity" than now contemplated. This will expand consumption and discourage further expansion of agricultural output.

SURPLUS POPULATION AS A FACTOR

Another important factor retarding increase in output per worker in agriculture is excess population on the farms, especially in certain regions like the Southern Appalachians, the Ozarks, and most of the South. These areas can be spotted on the map by their high rates of population increase, usually in spite of high infant-mortality rates. Where labor is abundant and cheap, farm work is done by hand, or with one-mule outfits. In Europe, much of it is done with cows used as draft animals. The crops grown are also likely to be those that use much hand labor, like cotton and tobacco. Nearly one half of the farms in this country are in these congested areas. There cannot be any rapid gain in output per worker with one half our agriculture continuing on this basis.

Of the nearly 5,000,000 who have left our farms since 1940, certainly not more than 1,000,000 are needed to replace the farmers who are past retiring age, and the women and children doing so much farm work now. The 4,000,000 remaining must have nonfarming jobs; likewise several hundred thousand new farmer sons and daughters coming of age each year.

The process by which the excess labor supply of the farms is drawn off to the cities is of two patterns, to which I shall apply the simple words "pull" and "push." (If I were a sociologist, I might use words with four syllables in place of four letters.) In normal years a considerable fraction of the young people on the farms are each year pulled to the cities by the prospects of higher earnings and/or better living. More are pulled to the city in good times than in bad. Estimates have been made that 5,000,000 moved to the cities between 1920 and 1930. But part of these went back to the farms in 1931–1933. Perhaps 4,000,000 were dammed up back on the farms in 1939. They were mostly not unemployed; they were underemployed. Usually many more have gone to the cities seeking for jobs than have been able to find them. There is a constant large flow in both directions, part of it seasonal and part of it not. Those farm workers who have gone to the cities for winter work have usually returned to the farms only because they have not found summer jobs.

When the "push" operates, people leave the farms because they cannot make a living there any more. This happens when a machine comes in that is so much more efficient than hand labor that it takes away the workers' jobs. It does this in part

by making the price of the product so low that farm families cannot make ends meet any more unless they use the machine Thus, the making of cotton cloth in factories in India starved out the families that had spun and woven by hand in their homes. Gandhi, it will be remembered, asked for a return to the spinning wheel. The Japanese did not make this mistake. The Chinese will not make it, either. A disaster, like the boll weevil, or the dust-bowl drought, may also force farm families out. The families "tractored off" the land in Steinbeck's "Grapes of Wrath" were dusted out too.

The "push" process is revolutionary, and hence painful. But its total effect is usually beneficial. One generation suffers, but those following are much the better for it. Without such revolution, it is doubtful if the problems of India or China will be solved and probably not those of our own South. The mechanical cotton picker, to be discussed later, is likely to operate on the push principle. The new developments in sugar-beet growing, i.e., seed treatment to save thinning, and mechanical harvesting, will reduce greatly the use of migrating gang labor. As will be indicated later, the push principle may even begin to operate in some dairy-farming regions.

On few occasions in modern history have farm and urban earnings and living conditions been equalized in any country. This is because birth rates are higher on farms than in cities, and because a declining fraction of incomes has been spent for food and fiber. Seldom has migration been fast enough to offset these two influences. Could we have high-level employment, however, what with modern roads and means of communication, and such rural education as we have, several hundred thousand more than the prewar "normal" would migrate to the cities each year. But a point would be reached within a decade at which higher farm returns per worker, shorter working hours, easing of the strain of farm work by the use of power, and better home conveniences and comforts would begin to check the rate of flow to the cities. It would be reached on family-sized farms in the Midwest within a few years and very shortly in the better areas in other regions.

LOW-INCOME AREAS

This raises the question of regional and area differences in migration and innovation. Farm and nonfarm income and living have been in pretty good balance in a large part of the Midwest much of the time since 1920. The average Iowa farm family has had as much real purchasing power as the average industrial worker in Iowa except possibly in 1931–1932. Corn Belt farms bought tractors and companion equipment in large volume in 1935–1941. Getting labor-saving equipment used on farms is a really difficult problem only in the sections where farms are too small and the farmers do not earn enough to pay for it.

Note particularly the statement "farms are too small." Most economists writing on this point would have written instead, "land is too poor." But commonly the land classified as poor will yield a net income if properly used; the difficulty is rather that the farms do not include enough acres of it. Close together in Illinois are the two counties, Douglas and Jasper. In the first, farms averaged $3530 of gross product in 1939, and in the second, $970. But the Douglas County farms contained 184 acres and the Jasper 120 acres. The Douglas farms also averaged 96,500 pounds of organic matter per acre, and the Jasper 43,100, with nitrogen, phosphoric acid, and potash in about the same proportions. The Douglas County crop yields were nearly double those of Jasper County. Thus, to give the farmers command of the same amount of soil resource, about 2 acres of Jasper County land are needed for 1 acre of Douglas County land. To be equal in resources to the Douglas County farms, the Jasper County farms would need to have 380 acres. Farmed as in 1939, the gross product of 380 acres of such land would be $3000. Farmed with modern power equipment, however, and using plenty of lime and fertilizer, and good forage and pasture plants, these acres might easily produce as large a net return as the 184 Douglas County acres.[5]

Probably some land is so poor that the more one uses of it, the smaller are one's earnings.[6] But in most situations the difficulty is not enough acres of the poorer lands and wrong use of them. In many sections, the poorer the land the fewer acres in the farms, and contrariwise.

Why is this so? To begin with, the original homestead units were the same on both good and poor land. Surely the poor land was often as hard to reduce to cultivation as the good land. As a result, the families on the poor land rarely earned enough to buy more land, or to buy needed equipment and livestock. Being poor, they had too many children. The opposite conditions tended to prevail on the better lands.

If laborsaving is to make much headway on one half or more of the farms of the United States located on the less fertile lands, some procedure must be devised for enlarging and equipping them. One way to do this would be for some governmental agency to buy so-called poor land, recondition it, lay it out into economic units, and sell it back to owner-operators under long-term purchase contracts. The Soil Conservation Service has a program much like this, but it is not pushing it now, and may hesitate to do so when the war is over because of fear of criticism from the opponents of public ownership of land A much slower procedure will be to make credit more available than now to present owners who wish to enlarge their present farms. Such use of credit will be especially important in areas where the cotton picker is pushing out some of the families.

SCALE OF OPERATIONS

Why stop with farms of 160 to 380 acres? Will not laborsaving equipment be introduced more rapidly if farms are several thousand acres instead of a few hundred? And will not innovation proceed more rapidly? The answer is yes to both questions. The Russia of the Czars offered some striking contrasts between highly scientific soil management practiced on many of its large estates and the improvident management practiced on the mir lands. The contrast is not as striking in this country, but it is safe to say that the areas with relatively large potato acreages per farm in Maine make more use of certified seed than the areas of small farms; also fertilize more freely, and spray more often and more effectively, and that similar differences can be found in cotton growing, dairying, and most other lines.

Yet one cannot conclude from this that large farms will replace family farms. If for no other reason, society will oppose such a development. The recent report of the Special Committee of the Land-Grant College Association proposes general adoption of a graduated land tax on large holdings. More important, although the Russian, Lenin, once published a forecast of concentration of landholding in the United States in the hands of a small number of capitalists, and headline hunters have written about "factories in the field," only in the California and other fruit and truck areas, and in other specialized areas, have many new large units appeared in the last three decades. The South of course still has its plantations, and the West its ranches. The most important development in scale of operations has been the increase in size of family farms as tractors have replaced horses in the Midwest and Great Plains states especially. Corn Belt family farms are now pointing toward 240 to 320 acres. A Diesel-powered family wheat farm may run to 3000 acres. The family poultry farm of the future may include 5000 hens; one man is now taking care of that number of layers on a few farms.

Some exponents of family farming, however, are thinking in

[5] For more details on this comparison, see the recent report of the National Planning Association on "National Fertilizer Policy."

[6] Such land would be truly submarginal. Most land so called is not, it is merely being used in a submarginal way.

terms of smaller units than these. No doubt many full-time farms will continue to be smaller. Some farmers prefer to operate small units; some do not have the managerial capacity for more. There is a place in our agricultural economy for the small holding as distinguished from the family-sized farm. In general, however, the best defense for family farming is to make it efficient. This requires equipping it in such a way that the family labor is utilized to good effect.

The size pattern which the agriculture of this country is likely to assume will be highly varied; undoubtedly more large-scale units in some lines of production, but also a large further increase in part-time and largely residential farming as work weeks are shortened and more older people have social-security incomes and pensions. The in-between farms will spread out over a wider range because of the use of more power and machinery on family farms. The manufacturers of farm machinery have a social obligation to meet this wide assortment of needs. The part-time farmers need suitable power equipment as well as the family farmers. The success of the manufacturers in producing such equipment will influence greatly the trend of developments.

The increasing use of machinery on farms of all descriptions must not be thought of only in terms of hours of labor saved. Power machines make it possible to work the soil more thoroughly and in good season, and to cultivate more promptly after each rain. More important, they make the farm work easier and more interesting. They raise the standard of living of farmers.

Two other developments are also likely to be important in this connection. The first is the increase of custom work. When farm machinery becomes freely available again, large numbers of farmers will buy combines, corn pickers, hay balers, field hay choppers, and the like. Those who cannot afford new machines may wait, as they did in the case of tractors, until they can buy secondhand. But many small farmers will be left who will no longer want to bind and shock their grain, or pick their corn by hand, who will wait for the combine or picker to come down the road, as they did in the old days for the thresher. No doubt, also, an increasing number of machines will be owned by small groups of farmers.

CASE STUDIES

A close study of a varied group of innovations in agriculture would reveal many other factors affecting their rate of progression. A few examples will serve to illustrate this. The first silo in the author's home community must have been built around 1885. Twenty years later, a farmer who built one was still scoffed at in many neighborhoods. Remarks were passed about the folly of growing good corn and letting it spoil in a silo, and about how the cattle would not eat it till they were starved into it, and how it gave the milk a bad flavor. By 1925, scarcely a dairy farm in the region was without one or more silos. The silo came into use because the farmers having them produced more milk and made more money, and their cows came through the winter in better condition. The young men observed this even though their fathers denied it. The ensilage supplied something that was lacking in the typical winter ration. It could have been supplied in other ways, but only in ways that but few would adopt readily.

Alfalfa was introduced about the same time, and even today is grown on only some of the dairy farms in the region. Yet it really had more to contribute to most dairy rations than had corn silage, and certainly it was promoted much more vigorously by extension workers and the dairy journals. Its introduction presented many more difficulties. First of all, rotation systems had to be made especially for it. Then there were the problems connected with inoculating the soil, occasional winter killings, and the running out of stands on many fields. As a result, a majority of farmers kept on with their red clover and timothy mixtures. Perhaps more important than all these was the extra labor involved. Dairy farming with alfalfa and plenty of corn silage tends to be considerably more labor-intensive than old-style dairying, and the farms had become sized to operate under the old system.

Hybrid corn has come into use much more rapidly. About the only obstacle to be overcome has been the psychological one.

The application of lime and phosphate made much more headway in the period from 1936 to 1941, than before, mainly because it was subsidized by the AAA and by the TVA.

Yields of cotton rose from around 165 lb per acre in 1928–1930 to 245 lb in 1938–1940, in large part because the number of acres that could be planted without penalty was restricted by the AAA. At the same time, the percentage of the crop which is short staple (under 1 in.) has declined from 78 per cent to 43 per cent.

One who goes into the Piedmont areas of the Southeast for the first time to observe the work of the Soil Conservation Service with broad-base terraces, strip-cropping, contour cultivation, and other erosion-control practices, is likely to be startled to see how extensive the terracing was before the SCS came upon the scene. These old terraces were all of the bench type. At some period in the past a great innovation occurred. If these terraces had not been built when they were, much of the land would long ago have been rendered noncultivable. The local people have only vague ideas as to when the first terraces were built. The Soil Conservation Service considers that the broad-base terrace is better than the bench terrace. It will take time to see which stands up the better over the years in any particular area under actual farming conditions.

Few jobs on farms are as onerous as the twice-daily chore of milking. Yet the milking machine came into use slowly before the war. The principal reason for this is that the overhead is too large for small herds, this overhead including the work of keeping the outfit clean and in good working order. The other reason is that machine milking must be carefully done if it is not to intensify the mastitis problem.

FAST-MILKING METHODS

This leads to brief consideration of the new techniques in milking as a type of innovation. The main feature of these is massaging the cow's udder with a hot towel for a fraction of a minute and then applying the teat cups a minute later. The other part of it is machine stripping, which consists of loosening the teat cups when they crawl up on the nearly empty udder and massaging the udder briefly as the last of the milk flows out. With these techniques, the cow "lets down" her milk, the teats are distended, and the milk is removed at one operation. The total milking time is apparently reduced about one half. If the operation is performed according to rules, there is no tugging of the machine on the empty udder and no injury to it.

The theory on which this technique is based was worked out by Prof. W. E. Peterson of the University of Minnesota.[7] A few farmers had for some time been using hot towels to stimulate the milk flow. The wartime shortage of labor on dairy farms has aroused widespread interest in these techniques. Many of the state extension services in the North and West have given special attention to promoting their use. One of the milking-machine manufacturers has furnished a good deal of assistance. Here is a chance to see an innovation actually under way. Following are examples of statements that have been furnished the author recently:

> Fast milking is an excellent example of a new technique which costs the farmer nothing to adopt and will save him a good deal of money. It relates to an operation performed 730 times a year and is more like factory operations than most of those on the farm. Consequently, we may expect to see it adopted more rapidly than the costly things we have mentioned before.

[7] "The Cow's Udder," by W. E. Peterson, University of Minnesota Bulletin 361, June, 1942. Reprinted April, 1944.

Fast milking is not new. Dr. Babcock wrote about it many years ago, and it has been taught by some people for a long time. Recently, however, some new fundamental information has enabled us to improve the process. This is so recent that few folks have had time to adopt it. On one farm, one man is milking 80 cows morning and evening alone at the rate of approximately 36 cows per hour. He has developed a milking stable and stalls that facilitate fast milking.

Our studies and trials in this state indicate that cows should be milked in $3\frac{1}{2}$ min or less instead of the 9.7 min found to be the average in a recent survey. In fact, if more than $2\frac{1}{2}$ to 3 min are used per cow, the operation should be looked into for waste of time and effort.

(From a Western state.) At our model dairy farm, which has a milking parlor, one man milks up to 120 cows twice a day. Each milking takes $2\frac{1}{2}$ hr. An outside man washes the cows and turns them into the lane leading to the milking barn. (This is 2.5 man-min per cow.)

(From a Southern state.) Most milking-machine users are adopting some features of the fast-milking program, but very few are carrying it out in every detail. In the barn operated by our dairy department, which has a milking parlor, four men are milking 135 cows twice per day in 3 hr. (This is 5.4 man-min per cow.)

Probably half of those with milking machines in this state have adopted the fast-milking technique. It has been found satisfactory both from the standpoint of laborsaving and decrease of udder troubles such as mastitis.

(From a Midwest state.) Machine milking is becoming more general and would be even more prevalent if the milking machines and essential air lines and pipe fittings were available. There is a definite trend toward operating milking machines according to the manufacturer's directions for rapid milking. Probably a fourth to a third more of the machine-milked herds in the state are being milked more nearly on the so-called "three-minute" basis than were so milked a year ago. The importance of rapid milking has been stressed in our program to reduce mastitis.

On one dairy farm in this state which has a milking parlor, four men are milking 275 to 300 cows in a four-hour period and also doing the herding, washing, and feeding. Before the parlor was built and the pipe lines installed and the new techniques were introduced, eleven men were employed to do the same work. However, this herd is entirely free of mastitis. We have found that the use of Professor Peterson's technique, which suggests discarding hand-stripping, leads to udder infection particularly among the older cows. Heifers can be trained to give down their milk rapidly and completely, but many of the older cows are too much accustomed to slower methods of milking.

Milking machines are not being used as widely as one might expect, to say nothing about the fast-milking methods. Some large dairy farmers have quit using the machines because of trouble with mastitis. With personnel changing constantly on these farms, it is not possible to use the machines as they should be used.

(From a Midwest dairy state.) We have given some attention to the fast-milking idea in our extension and educational work, but I surmise that few of our dairymen have adopted it as yet. The whole idea of fast milking is unconventional to a dairyman and he is reluctant to embrace such ideas. However, the practice has such advantages that we predict its wider adoption.

We are employing one extension worker who goes from farm to farm helping the farmer to introduce this new milking technique. We have in mind getting 25 or 30 such co-operators in a county, who will act as sponsors or teachers. In a period of four months, this man has worked with 50 farmers, and 20 are now full-fledged co-operators. In contrast to this approach to the farmers may be mentioned the fact that last winter 909 farmers attended special rapid-milking meetings, and a later check-up showed that very few of them had actually adopted the rapid-milking methods.

The "three-minute" milking technique has been adopted quite rapidly by the farmers using mechanical milkers, but no reliable estimates are available as to how many have adopted the practice.

Fast milking is practiced on about half the farms in this state where machines are used.

I do not really know of a single dairy in this state which is using the fast-milking technique.

Aggressive dairymen in this state recognize the value of fast milking and many doubtless are profiting by it; but even greater savings in labor can be made by carefully routing the milker as he moves about his work of feeding, milking, and handling milk so as to avoid backtracking and unnecessary steps and operations.

Here one sees in cross section the usual types of hindrances to the adoption of a new invention or technique. By no means are they all out on the farms; some of the agricultural colleges are showing little interest in the new milking techniques and a few are a bit offish toward them. On the actual farms, some real obstacles need to be surmounted; if the milking machines now on farms are frequently used incorrectly, how about these new techniques? More important, these techniques do not stand by themselves; the whole milking operation needs to be replanned if the time saved in actual machine operation is not to be lost in handling the cows, milk, and equipment. Without detailed guidance, a majority of dairy farmers will not carry out this replanning successfully.

Other developments that may reduce labor and other costs on dairy farms are the open-shed-stable plan of housing the herd, automatic barn cleaners, and manure loaders.

Just what line the developments in hay harvesting will take is a subject of debate at present. Probably in the western hay-growing regions, the new one-man pickup hay balers, with a bale-loading attachment, will capture the field; but in regions where the hay is fed on the same farm, either chopping the hay green for grass silage, or chopping it dry and blowing it into the mow, may take precedence. In other regions, barn-drying of hay, now best developed in Virginia, may win out.

Here, obviously, is a group of developments which point in the direction of greater efficiency in livestock farming. Most of those in the past have favored crop farming.

COTTON PICKING

Secretary Wickard in his recent testimony on the cotton problem spoke of two kinds of cotton-harvesting equipment; one a mechanical stripper used on the high plains of Texas, which reduces the harvesting time to 4 or 5 man-hr per acre, and the total labor time for the crop to 8 hr per acre; the other the mechanical picker, which, combined with 4-row tractor equipment for the other operations, reduces the labor time on Mississippi Delta cotton from 150 down to 25 or 30 hr per acre. An agronomist in the Carolina Upper Coastal Plain reports 38 bales of cotton from 25 acres on one farm without any hand labor except for picking, and adds that the cotton-picking machines demonstrated in his area this year were definitely successful.

But whether cotton growing and harvesting on the small irregular fields in other parts of the South can be mechanized successfully is another question. Certainly mechanization will not offer as clear advantages on such fields as on those mentioned. We can therefore expect that mechanization will not only push labor off of Southern farms, but will cause cotton to shift toward the sections which it favors. Artificial price supports can retard such developments, but not stop them. Government aid had best be used to facilitate rather than to prevent them. Secretary Wickard's Reconversion Program for the South is pointed in this direction.

WARTIME DEVELOPMENTS

The increase in agricultural output in this country during the war has been due less to more efficient use of labor than commonly supposed. The men who have left the farms have been replaced in large part by older men, women, boys, and girls; and work hours have been lengthened. But some important reductions in labor input per acre and per animal unit have occurred. New machinery has helped a little, especially in some lines, but more important has been a much fuller use of the machines already on farms. Machines that before the war did work only on the owner's farm have often worked on three or four.

Also the pressure of work has called forth an amazing amount of ingenuity. From the West come reports of thousands of improvised power buck or sweep rakes made by attaching the sweep to tractors or trucks or heavy-chassis automobiles.

(*Continued on page 198*)

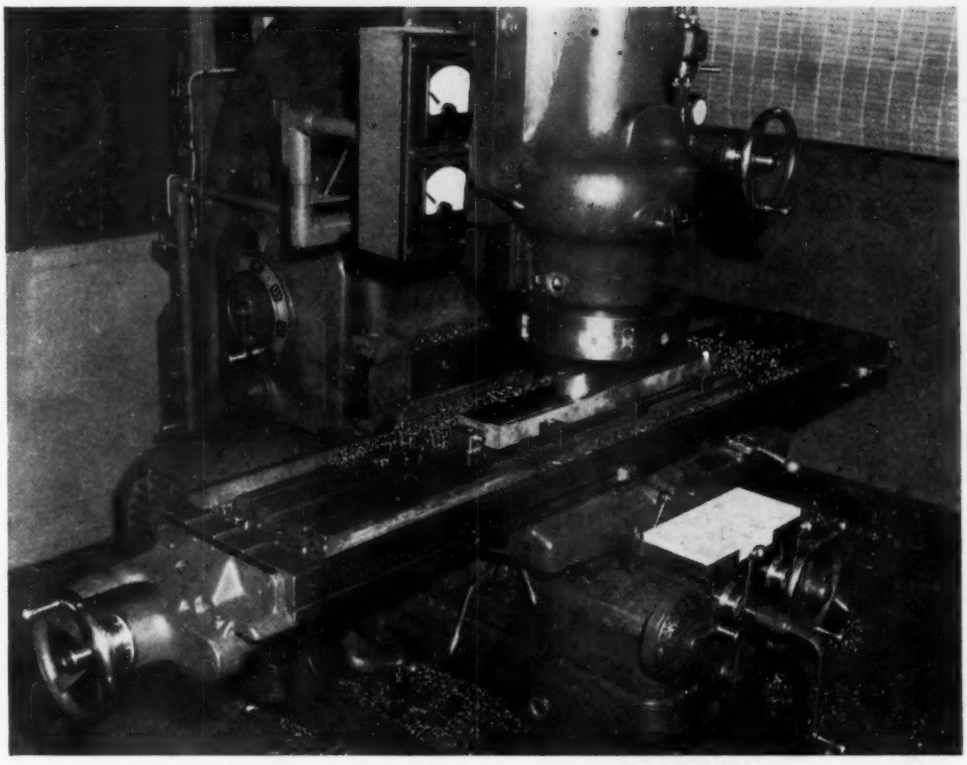

FIG. 1 TYPICAL SETUP OF MACHINE USED

A Study of Some Fundamentals When FACE-MILLING *Steel With* CARBIDES

The Radial Rake Angle

By FRED W. LUCHT

DEVELOPMENT ENGINEER, CARBOLOY COMPANY, INC., DETROIT, MICH. MEMBER A.S.M.E.

THE correct radial rake to be used on carbide cutters for milling steel has generally been determined by "cut-and-try" methods. No authentic information based on controlled tests has been available. For this reason, an investigation into the subject of radial rake for the face-milling of steel with carbides has been included in the steel-milling development program now being conducted at the engineering research laboratory of the author's company in Detroit. This paper is a report on the progress of the investigation on radial rakes to date. This study is still in progress because it is thought that the use of the proper radial rakes on a cutter, the correct method of maintaining them, and the correct method of positioning them in relation to the point where the tooth enters the work, all have a direct bearing on the success or failure of a steel-milling operation.

TEST CONDITIONS

In establishing the procedure to be used throughout the proposed extensive series of face-milling-test runs, S.A.E. 1045 steel was selected as the material to be machined because it was considered to be the most representative of all the steels commonly milled today with carbide cutters. The steel billets were forged to a uniform size, i.e., 5 in. × 6 in. × 36 in. All corners had a maximum radius of $^1/_8$ in. The forged billets were heat-treated and drawn to a hardness of 190–210 Brinell.

All tests were run on a No. 5HM vertical milling machine, as shown in Fig. 1, with separate motors for spindle drive and feed. At the main spindle, 20 hp was available, and 5 hp for the feed and rapid traverse. The machine was equipped with two separate wattmeters, together with appropriate current and potential transformers to measure the power actually consumed by the main spindle motor, and the feed-and-rapid-traverse motor.

The cutter head of the face-milling cutter was made from a steel forging, as shown in Fig. 2. It was located from and bolted to, the spindle nose of the machine. The slot for the tool bit is parallel to the axis of the cutter head, and the tool bit is clamped in place by setscrews.

In all, eleven different designs of tool bits, as shown in Fig. 3, were used. Each tool bit had a 10-deg negative back rake. When the bit was assembled in the cutter head, this 10-deg

Contributed by the Metal Cutting and Production Engineering Divisions and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

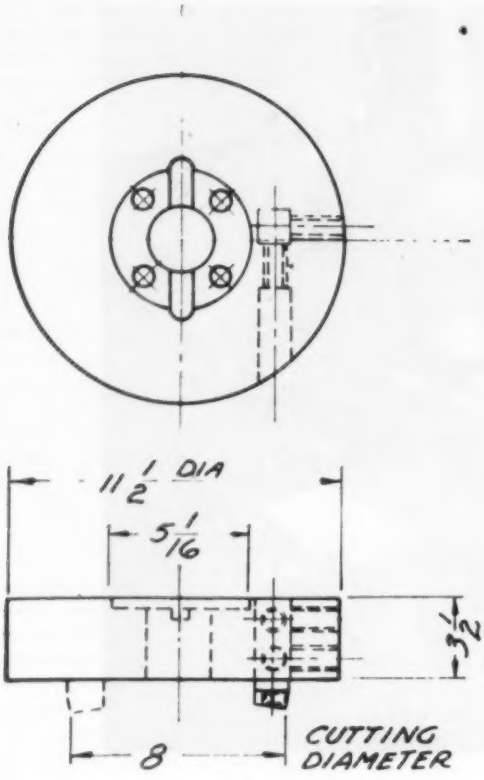

FIG. 2 CUTTER HEAD - TOOL BIT ASSEMBLY

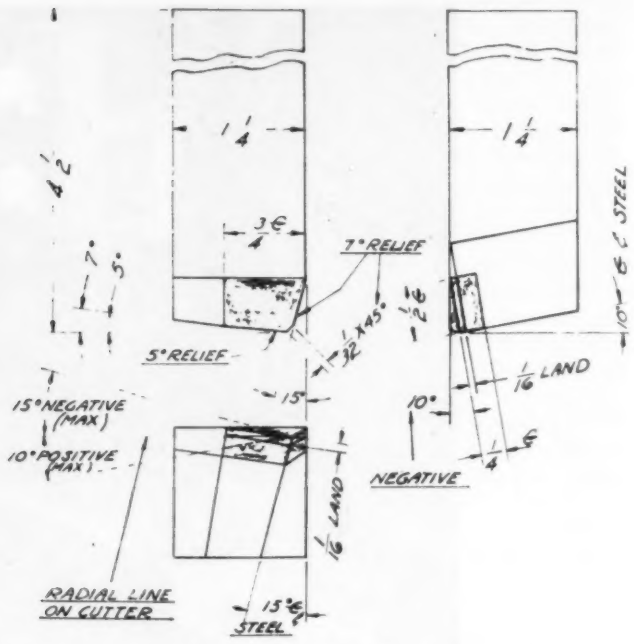

FIG. 3 ALL TOOL BITS USED HAD 10-DEG NEGATIVE BACK RAKE AND VARYING SIDE RAKE

negative back rake produced a 10-deg negative axial rake. Side rake varied, each tool being given a different one. These side rakes were 15, 12, 10, 8, 5, and 2 deg negative; zero deg; and 2, 5, 8, and 10 deg positive, respectively. When the tool bit was assembled in the cutter head, each of these side rakes produced a corresponding radial rake.

All tools had tips of Carboloy Grade 78B, which is a steel-milling grade of carbide. All tips were ground on a single-point tool grinder using a 60-grit silicon-carbide wheel for roughing both the carbide and the steel. A 220-grit diamond wheel was used for the final sharpening of the carbide only.

The cutting edges on all tools were inspected at 20 magnifications before each milling run started. Each edge was brushed lightly with a 320-grit silicon-carbide stone at about a 45-deg-angle to the face of the tool to remove any slight irregularities before assembling the tool in the cutter head.

Preliminary runs showed that an 8-in-diam face-milling fly-cutter (with only one tooth) gave extremely erratic results for feeds per tooth greater than 0.006 in. However, when feeds per tooth were increased to more than 0.010 in., the gears in the spindle clattered and the machine developed a tendency to "dance" on the floor.

In an effort to overcome this difficulty, the cutter head was enshrouded with a steel flywheel measuring 18 in. diam and 4 in. thick; this is shown in Fig. 4. The addition of the flywheel brought the weight of the combined unit, i.e., cutter head and flywheel, to 255 lb. This weight was well within the weight limit of the spindle, which was 500 lb. The flywheel unit, Fig. 5, was carefully balanced with the cutting tool in place. Use of this flywheel made it possible to obtain uniform results where before they had been erratic. It also permitted the use of feeds per tooth as high as 0.040 in., without any undue gear clatter or machine vibration.

Fig. 6 shows the setup which was used while making all the runs. The outside diameter of the cutter overhung the work $1^3/_4$ in. at the side where the cutting edge entered it. This setup permitted the cutting edge to contact the work back from the cutter face, as indicated at *B*, because this condition is

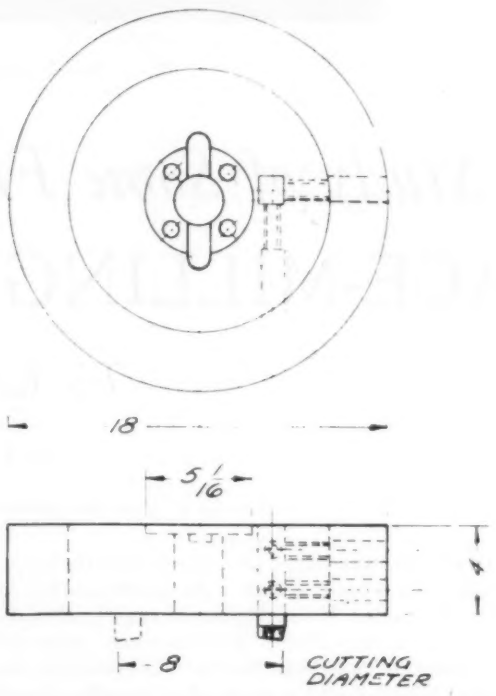

FIG. 4 TO ELIMINATE VIBRATION, CUTTER WAS ENSHROUDED IN A FLYWHEEL

known to improve cutter life. This positioning of the cutter in relation to the work also places a positive pressure toward the column of the machine and tends to eliminate chatter.

PROCEDURE FOLLOWED IN TESTS

Previous runs had indicated that a speed of 238 rpm (498 fpm) with the 8-in. face mill gave the longest cutter life when milling S.A.E. 1045 steel heat-treated to a hardness of Brinell 190–210. Therefore, this speed was used throughout on the radial-rake tests.

A feed of 2 ipm, which, under these conditions, was 0.0084 in. per tooth, was maintained. This had two advantages: (1) It is about the minimum feed per tooth which gives good cutter

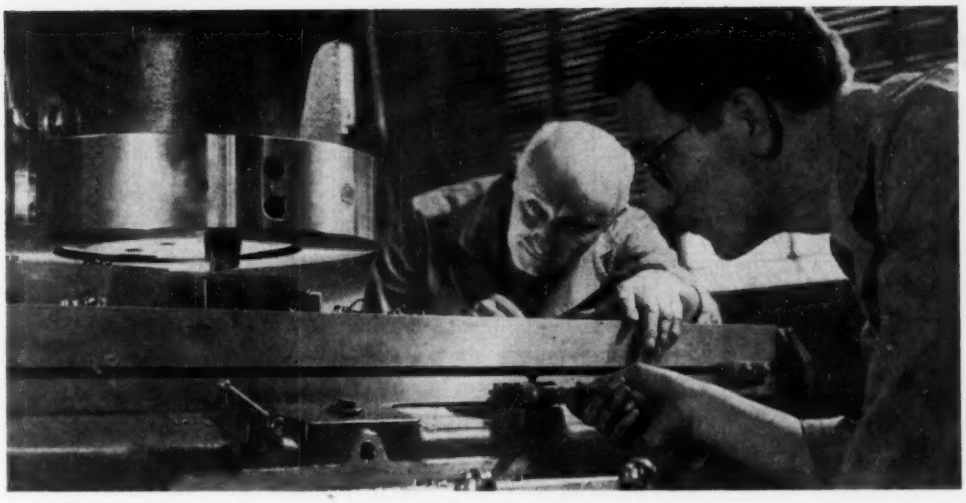

FIG. 5 FLYWHEEL - CUTTER HEAD - TOOL BIT UNIT IN RELATION TO WORK

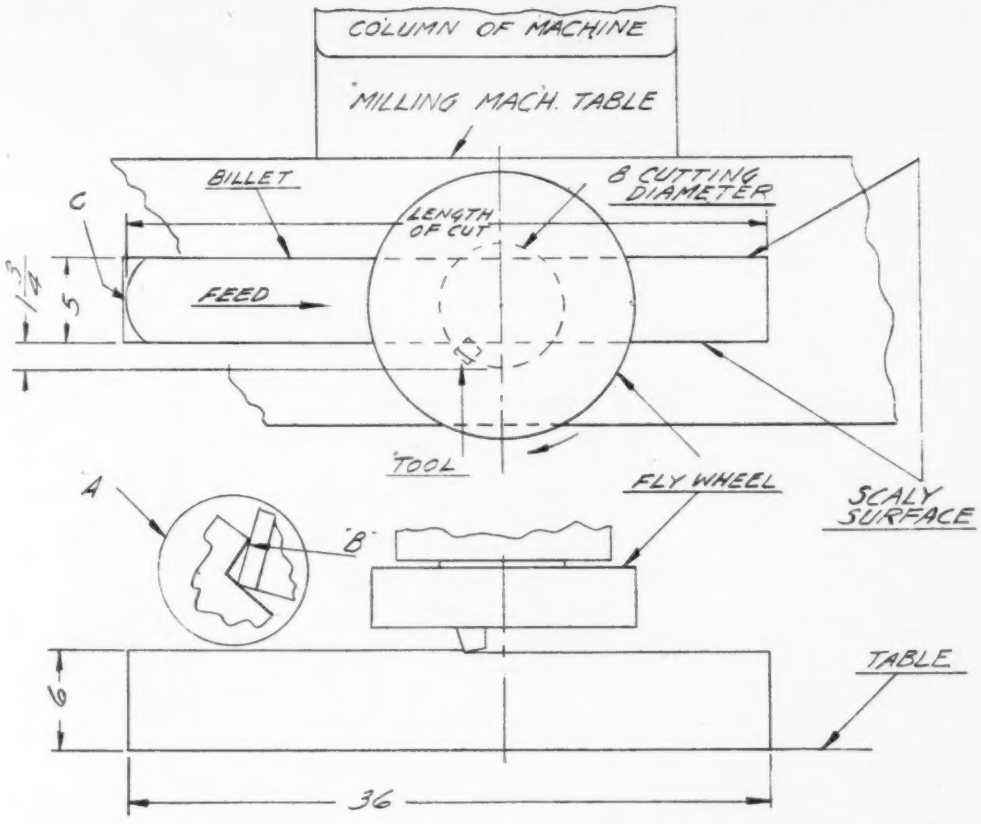

FIG. 6 SETUP SHOWS CUTTING EDGE CONTACTING WORK BACK OF CUTTER FACE

life; and (2) this feed can be obtained on most of the present-day milling machines, providing that the number of teeth in the cutter is kept down so that the power required will be within the capacity of the machine.

A depth of cut of $^{5}/_{32}$ in. was selected for all tests. This figure was chosen because it represents the average depth which will cause wear similar to that obtained by machining deeper cuts, and yet which does not necessitate the removal of an excessive amount of steel.

As a further safeguard against erratic results, and also to help provide identical conditions on each run, the cutter was not allowed to break through the end of the billet, as indicated by *C*.

Each tool was run until the first sign of wear, shown in Fig. 7, was noted on the chips coming from the cut. As soon as a well-defined deep blue line paralleling the length of the chips appeared, indicating the first breakdown or chipping-out of the tool's edge, the run was stopped and the tool removed from

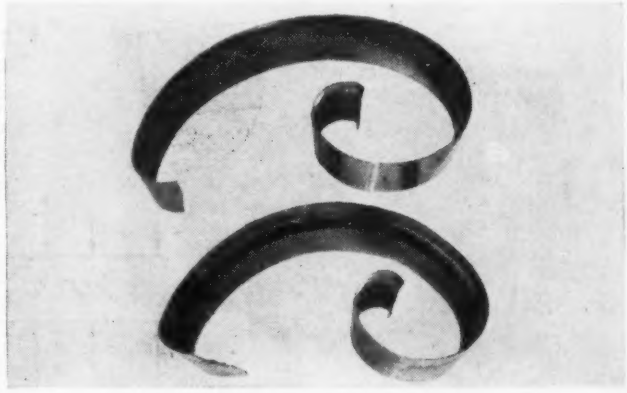

FIG. 7 FIRST SIGNS OF TOOL WEAR SHOW UP ON CHIP (Bottom chip shows a well-defined line paralleling length of chip.)

LABORATORY TESTS - MILLING

MATERIAL 1045 BRINELL 197-212 GRADE 78B DATE 7-17-44

SPEED RAM	SPEED FPM	FEED IPM	FEED IRT	D	CUT W	CUT L	TOOL RAKE A	TOOL RAKE R	POWER SP	POWER ED	TOOL WEAR	REMARKS
		1ST RUN							4.5 TO END UP TO 6.5		.030 .040 .070	.005 EDGE WEAR .020 CRATER
238	498	2	.0084	3/32	5	71	-10	-12		6		
		2ND RUN							4.5 TO END UP TO 6.5		.032 .035 .050 .050	.008 EDGE WEAR .030 CRATER
						70 1/4		-12		6		
		3RD RUN							4.5 TO END UP TO 6.5		.032 .045 .065	.010 EDGE WEAR .030 CRATER
						71 1/2		-12		6		
		4TH RUN							4.5 TO END UP TO 7		.030 .040 .060	.010 EDGE WEAR .022 CRATER
						70 3/4		-12		6		

FIG. 8 SHEET USED TO RECORD ALL DATA

D, Depth of cut
BA, Bevel angle
C, Chamfer
F, Length of wear land on face of cutter
WBA, Width wear land on bevel angle
WC, Width wear land on chamfer
WF, Maximum width wear land on face
T, Face of cutting tooth
X, Original outline of cutting tooth
Y, Outline of tooth after breakdown occurred and wear was recorded
V, Points of breakdown
H, Fair hair-like lines. Many of these only become noticeable at 20 magnifications
P, Width of crater
M, Amount of cutting edge worn back up to the time breakdown occurred

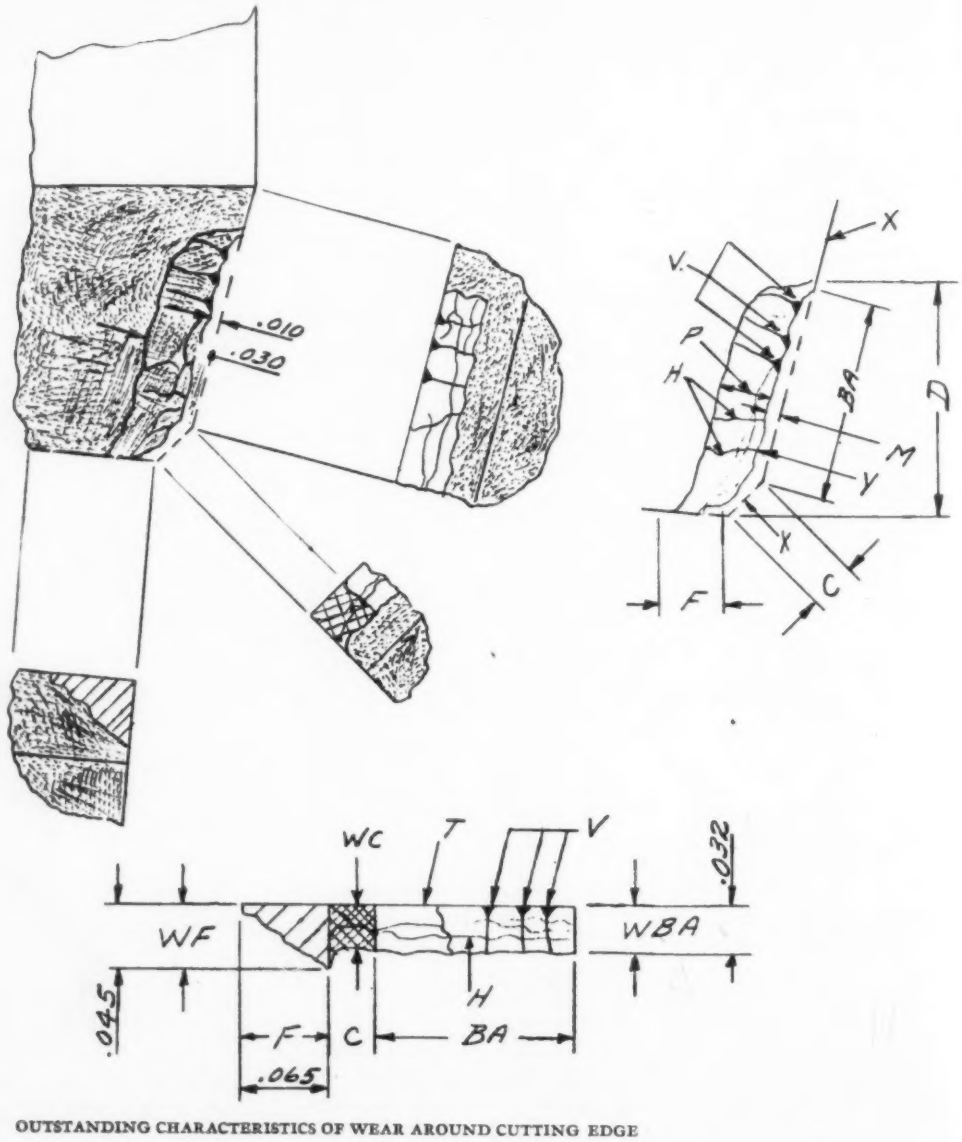

FIG. 9 OUTSTANDING CHARACTERISTICS OF WEAR AROUND CUTTING EDGE

the cutter head. The machine operator can also easily detect the moment that breakdown of the cutting edge takes place because it is accompanied by a characteristic change in sound.

The exact nature of the tool wear was determined by analysis and recorded as shown in Fig. 8, after each tool had been run. This was done by inspecting the tool with a 20-power glass. The widths of the wear lands along the bevel angle, chamfer, and face; the distance which the cutting edge had worn back from the original bevel outline; and the width of the crater on the face of the tooth were all determined. These values were then represented in a freehand sketch which showed the development of the cutting edge. All unusual signs of breakdown of the cutting edge were indicated in this manner. Fig. 9 gives added detail on the breakdown of the cutting edge.

Incidentally, use of this method of recording wear on a tool might be recommended when reporting milling jobs on which assistance is requested from carbide-tool suppliers. Such sketches have been found to be most helpful in analyzing wear factors and eliminate the necessity for sending the actual cutting bits or tool blades.

RESULTS OF TESTS

At the conclusion of the series of runs, the results of the tests were graphically portrayed, as shown in Fig. 10, by plotting the number of linear inches milled by each tool up until the time that the cutting edge first showed signs of failure. One line was then drawn through the points showing the maximum number of inches milled. A second line was drawn through the points indicating the minimum number of inches milled in each case. The result was the graph shown.

Under the specific conditions of the test, the following conclusions have been reached:

1 A 10-deg negative radial rake gave the longest cutter life for each run.

2 A 12-deg negative radial rake gave shorter but more consistent cutter life for each run.

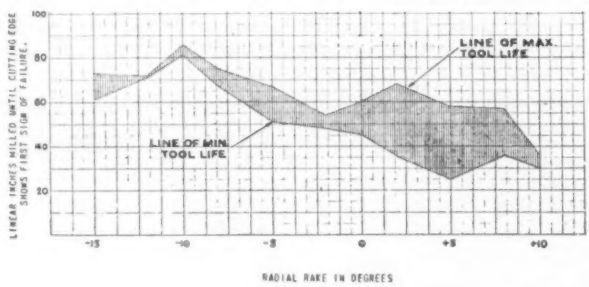

FIG. 10 A 10-DEG NEGATIVE RADIAL RAKE PROVED TO BE MOST SATISFACTORY

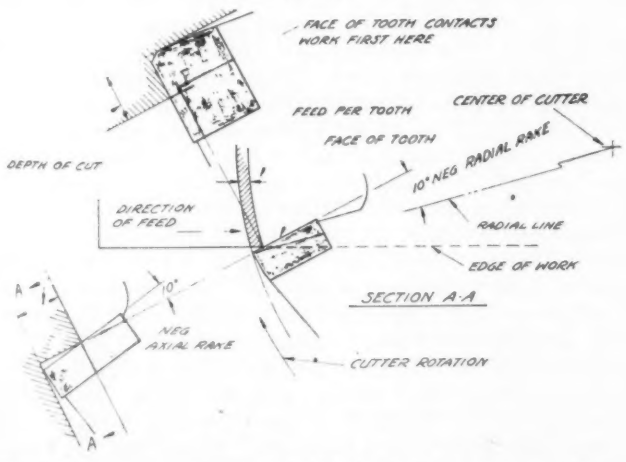

FIG. 11 LAYOUT SHOWING WHY 10-DEG NEGATIVE RADIAL RAKE COMBINED WITH 10-DEG NEGATIVE AXIAL RAKE GAVE LONGEST CUTTER LIFE

3 Negative radial rakes greater than 12 deg gave still shorter cutter life, together with wider fluctuations.

4 Negative radial rakes less than 10 deg gave the shortest cutter life. Wide fluctuations were noted.

5 Minimum cutter life, together with extreme fluctuation, was obtained with positive angles.

In order to determine the reason why a 10-deg negative radial rake gave the longest cutter life, the relationship of the negative radial rake angle on the face of the tool was carefully checked with the outline of the work at the point where the cutting edge along the bevel angle entered the cut. It was found that this gave the set of conditions shown in Fig. 11.

In other words, the best operating conditions will be obtained when milling steel with carbides if the face of the tooth first contacts the work at a distance equal to the feed per tooth back from the cutting edge, and at a distance from the face of the cutter which is equal to the depth of cut.

An All-Year Gas Air-Conditioning Unit

(*Continued from page 174*)

moisture is extracted at the rate of 15 lb per hr from the air stream when the unit is in operation at full gas input.

The all-year air conditioner can be applied to all types of comfort cooling and heating applications which fall within the performance characteristics enumerated in this paper.

Specifically, such a field includes the residential market. From an application engineer's point of view, the architectural arrangement of the residential structure will many times indicate a need for a multiple-unit installation or a zone system for greater flexibility of system operation. Such adaptations are readily possible with the range of capacities available.

The field of application includes the commercial comfort cooling and heating market, covering single- and multiple-unit requirements. In the latter category, application engineering judgment will often favor selection of a zone type of system, thus providing greater operating flexibility where usage or shape of structure dictates. All of the requirements of a completely coordinated all-year system have been provided in one simple unit.

Too many of our graduate students in science are suffering from a kind of intellectual scurvy. This is essentially a deficiency disorder arising from a restricted intellectual diet. Unfortunately these disorders of education are not so easily cured as is real scurvy, which may be alleviated by a minute amount of ascorbic acid. Habits of thought and intellectual outlook cannot be changed by taking pills. The youthful scars of intellectual malnutrition are hard to clear and frequently last throughout life. For this reason it is much better to avoid such intellectual deficiencies by making use of a well-balanced educational diet.

To carry this analogy just a little further, we have learned that our material nutrition is not to be judged entirely by the energy value of the food consumed, such as carbohydrates, fats, and proteins. The small amounts of vitamins which may accompany these foods are not measurable in terms of the old concepts of caloric value. Similarly, to a youth aspiring for a scientific career, the benefits of the study of languages, history, literature, and philosophy are not to be measured simply in terms of the factual material acquired. Beyond this there are accessory vital factors, intellectual outlooks which transcend any such narrow appraisal. These accessory factors may be regarded as the intellectual vitamins. Their influences are far more subtle and mysterious than are those that control the growth of a child playing in the sunlight. Yet, like this sunlight, they may determine the stature, well-being, and happiness of the mature man throughout his entire life.—H. A. Spoehr in *American Scientist*, January, 1945.

Some Recent Developments in ENGINEERING MATERIALS[1]

2 *Nonferrous Metals*

By ARCHIBALD BLACK

MANAGER, MECHANICAL ENGINEERING DEPARTMENT, SIMMONDS AEROCESSORIES, INC., NEW YORK, N. Y. MEMBER A.S.M.E.

ALUMINUM

NEW high-strength aluminum alloys have recently been announced by the Aluminum Company of America (75S alloy) and by the Reynolds Metals Company, (R301 and R303 alloys). The 75S and R303 alloys are of the aluminum-magnesium-zinc-copper type. The high-strength characteristics of this type of composition was recognized many years ago but problems of stress-corrosion-cracking prevented their development until these could be solved. By 1939, success was attained in the laboratory of the Aluminum Company of America, and by 1943, the new 75S composition was put into production.

The exact composition of 75S and R303 alloys is still withheld from publication, but figures on their physical properties have been released. These alloys show ultimate tensile strengths ranging from over 70,000 to 88,000 psi, depending upon the type of heat-treatment, aging, and also the amount of prior working. Yield strengths are also high, ranging from 69,000 to 82,000 psi with elongation between 9 and 11 per cent. Both alloys are available as clad sheets as well as in the unclad form. Modulus of elasticity is 10,300,000 psi, and the specific gravity is between 2.82 and 2.83. Resistance to corrosion compares very favorably with that of older high-strength aluminum alloys, exceeding slightly that of bare 24S-T.

The R301 alloy offered by Reynolds differs only slightly from 14S and 24S in composition but is clad with a high-strength low-corrosion alloy. This sheet has excellent forming properties and develops 59,000 to 69,000 psi, depending upon the aging treatment used. The cladding is a magnesium-silicide-type alloy and is both highly resistant to corrosion and anodic to the base metal so as to afford electrolytic protection.

Considerable work has also been done on the effect of aging 24S-T alloy at elevated temperatures after varying amounts of strain-hardening by either rolling or stretching. As a result, it has been found possible to increase the ultimate tensile strength of clad 24S-T sheet by a few thousand pounds per square inch, but the yield strength may be increased by upward of 20,000 psi.

Refrigeration of Heat-Treated Aluminum Alloys. Although not a new development, the vast extension of the use of refrigeration of heat-treated aluminum in recent years warrants at least mention of it here. As is well known, many aluminum alloys age-harden at room temperatures after the heat-treatment. For a relatively short time after the heat-treatment (for 17S and 24S a few hours), they are still relatively soft and may be cold-worked. After this, rivets become too hard to drive without cracking. Advantage has been taken of this fact in the use of aluminum-alloy rivets which are usually heat-treated and then driven, after which they age-harden as a result of the heat-treatment.

In aircraft factories it was found rather inconvenient to be forced to heat-treat small batches and to see that these were driven within the relatively short time before the heat-treatment began to result in age-hardening. Fortunately, it was found that the age-hardening could be delayed indefinitely by lowering the temperature of the rivets after the heat-treatment. As a result, equipment was installed to maintain the temperature of the rivets below 32 F after heat-treatment and until they were needed for use. The process now in use is to heat to 910 to 930 F for 24S, or to 930 to 950 F for 17S, quench in cold water, and then chill to about 0 F, at or below which they are stored until required for use.

"Vanasil," a Low-Expansion Aluminum Alloy. High coefficient of thermal expansion has always been one of the outstanding characteristics of aluminum alloys. It is thus of interest to note that some new aluminum alloys have been produced with coefficients of thermal expansion very close to that of cast iron. Some alloys having this characteristic have been developed in Germany and in the United States.

The coefficients of one of the German alloys and of "Vanasil," an American alloy, are given in Table 3, in comparison with the ordinary aluminum alloys and cast iron.

TABLE 3 EXPANSION OF VANASIL AND OTHER ALLOYS

Material	Coefficient of thermal expansion per deg C
Commercial aluminum	0.000 023
Alcoa No. 132	0.000 019
Schmidt alloy (German)	0.000 0175
Vanasil	0.000 0165
Cast iron	0.000 012 to .000 013

This alloy contains a total of 21 to 23 per cent of silicon, and its manufacture requires the compounding of a hypereutectic alloy of aluminum and silicon to which copper, magnesium, and nickel are then added. The specific gravity is 2.62, as compared with 2.70 for aluminum, and 2.63 to 2.94 for the general range of cast aluminum alloys. The tensile strength of this new alloy is given as 32,400 psi at room temperature, 30,300 psi at 300 F, and 23,150 psi at 500 F, thus showing what is for an aluminum alloy unusual ability to retain its strength at elevated temperatures. Its hardness is given as 100 to 160 Brinell at room temperature, and (as might be expected from the figures on strength) it retains its hardness well at elevated temperatures. Thermal conductivity is given as 0.3 to 0.35 in cgs units or about 3 times that of cast iron. No permanent growth in volume at high temperature has been observed. The coefficient of friction of Vanasil against cast iron at 158 F (70 C) has been found to be about 69 per cent of that of typical aluminum piston alloys under similar conditions of test. The modulus of elasticity is 15,000,000 or just below that of silicon and substantially above that of aluminum. Vanasil was developed on the West Coast about 4 years ago and is now being marketed by the Howell Engineering Company, New York, N. Y.

[1] The first installment covering "Ferrous Metals" appeared on pp. 101–108 of the February, 1945, issue of MECHANICAL ENGINEERING.

This section was contributed by the Metals Engineering Division and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Aluminum-Steel Bonding. A method of bonding aluminum to steel was announced early in 1944, by the Al-Fin Corporation of New York, a firm associated with the Fairchild Aviation group. Details of this process have not yet been released beyond the statement that it involves the casting of an aluminum case on a steel part. Basically, the process is one of casting aluminum around a steel insert; it results in forming, at the interface, an intermetallic compound of iron and aluminum which serves to bond the two metals solidly together in much the same manner as a welded or brazed joint. The process is being used at present to apply aluminum fins to steel cylinders of aircraft engines aluminum-lined steel bearings, brake drums, radiators, etc., but it offers promise in other applications involving rapid transfer of heat from steel parts.

Aluminum Plating. Aluminum, which was for many years regarded as "unplatable" by the electroplaters, is now being plated with nickel, chromium, cadmium, copper, zinc, silver, gold, and brass. The process was originally introduced early in the 1930's and is based upon the creation of an anodic film on the surface of the aluminum before it is plated. This film is then treated with an acid or alkaline solution to render it capable of "taking" the plating. Among other applications, this method is being used to plate brass on aluminum to provide adherence of molded rubber to the surface, since rubber will adhere to the brass but not to the aluminum. Another application is on aluminum condenser plates which are nickel-plated to facilitate soldering. Adhesion of the plating to the aluminum is claimed to be equal to that attained with certain other metals and better than zinc on steel.

MAGNESIUM

The last 10 years have seen the introduction of the magnesium-aluminum-zinc series of magnesium alloys, a group which shows improved corrosion resistance in the presence of salt air. The same period also witnessed the development of the "high-purity" alloys in which the iron content is held to a maximum of 0.005 per cent, with a further increase in the resistance to salt-water corrosion. Other advances in the magnesium-alloy field took the form of fabricating technique, and the development of vastly improved welding processes which have made it possible to apply magnesium to purposes for which it could not have been considered at one time. Of these improved practices, the most important is undoubtedly the application of helium arc welding which eliminates all need for a flux and has made the welding of magnesium as simple as that of welding steel. These developments have combined to increase enormously the use of magnesium-alloy sheet, forgings, and extruded shapes in aircraft, since they have the additional advantage of extreme low weight, their specific gravity being 1.76 to 1.83 as against 2.79 for aluminum alloys of the 17S type. Typical of the newer magnesium alloys is Dow O-1 which contains 8.5 per cent aluminum, 0.2 per cent manganese, and 0.5 per cent zinc. Its tensile strength is about 42,000 psi with 5 per cent elongation; and, since this alloy has a specific gravity of only 1.80 it shows up very well in strength-weight ratio, being about comparable with 17S aluminum alloy. The modulus of elasticity of magnesium alloys ranges from 6,200,000 to 6,600,000 psi.

Surface Treatment of Magnesium Alloys. When magnesium alloys first came into use, considerable trouble was experienced with corrosion, especially in the presence of salt water or moist salt air. Under these conditions, unprotected magnesium alloys behave somewhat similar to and somewhat worse than unprotected aluminum alloys. Investigation was made of the possibilities of surface treatment, in the hope of developing a process paralleling that of "anodic" finishes for aluminum and aluminum alloys. Out of this investigation came four processes which have accomplished much in improving the corrosion resistance of these alloys. One is the "chrome-pickle" treatment, which is suitable mainly for protection of parts during storage and shipment. Due to removal of metal in the pickling, this process should not be used where close dimensions must be held.

The chrome-pickle process consists of immersing the parts for about 1 min at room temperature in a solution of sodium dichromate and nitric acid in water. This is followed by a hot-water dip, and the part is air-dried. This process gives the surface a brassy and iridescent appearance and serves as a moderate protection for the metal.

More effective protection is attained by the use of the "dichromate" treatment which gives considerable inherent protection to the base metal and also serves as an excellent base for such type of paint coating as may be used to complete the protection. The dichromate treatment is not recommended for the manganese-magnesium type of alloy. The dichromate treatment is carried out in two steps: The metal is immersed for 5 min in a 15 to 20 per cent solution of hydrofluoric acid in water at room temperature. In the case of wrought metal, a solution of sodium, potassium, or ammonium acid fluoride is sometimes substituted but this alternate is not suited for castings. After the first dip, the parts are rinsed in water and then boiled for 45 min in a 10 to 15 per cent solution of sodium dichromate in water, and again rinsed. The dichromate process gives the surface a dark-brown to black color.

A third process, the "sealed chrome pickle," is also in use which is simply a variation of the first by providing for 30 min boiling in sodium-dichromate solution after the initial pickle. This process provides good protection, but as a result of removal of metal in pickling it is not suitable where close dimensional tolerances must be held. All of these processes depend for their effectiveness upon the creation of a surface coat of magnesium chromate.

Still another process, galvanic anodizing, is in use. This requires immersion of parts for 5 min in a 15 to 20 per cent solution of hydrofluoric acid in water, followed by a rinse, and then by galvanic anodizing in a bath containing an ammonium sulphate, sodium dichromate, and ammonia solution in water. This process results in a gray to black coat of chromic-magnesium oxide and is recommended for manganese-magnesium alloys where close dimensional tolerances are required.

BERYLLIUM AND BERYLLIUM ALLOYS

The element beryllium was first discovered in 1797, and was isolated as early as 1827–1828, but commercial production did not begin until about 1926 in Germany, and about 1931 in the United States. Extensive use of this metal has thus been made only within the past 10 years. The chief use of the metal is at present in the manufacture of beryllium copper, but its oxide finds important applications in fluorescent lamps, X-ray windows, and cathode-ray tubes, where use is made of its characteristic of transforming short-wave rays to visible light. Considerable research on the metallurgy of beryllium has been conducted within the last 20 years, particularly in Germany and the United States. To Siemens & Halske of Germany and to the Brush Laboratories of Cleveland belong credit for some of the most important commercial developments.

Beryllium has the property of imparting to several metals the ability to respond to heat-treatment. This list includes copper, iron, lead, nickel, and silver.

However, commercial development has been mainly confined to beryllium copper, because the high cost of the beryllium (about $15 to $17 per lb on the basis of the content of master alloys) has limited its use to cases where cheaper elements could not be used to attain adequate results. The application as an alloying element in copper is of outstanding importance, the effect of additions of beryllium to copper being almost comparable with that of adding carbon to iron to make steel.

Several firms are now producing copper alloys containing around 2 per cent of beryllium and, in some cases, other elements. These alloys are capable of showing very substantial improvement in tensile strength, and very substantial increase

in electrical conductivity, as well as the most unusual result of some increase in modulus of elasticity after suitable heat-treatment. The treatment of beryllium copper requires two heats; the first is followed by a quench and leaves the metal soft and workable, the second causes the material to age-harden. It makes no difference in the results whether this second heat is followed by a quench or the metal allowed to air-cool. The temperatures required vary with the composition but the following is typical:

An alloy of 2.25 per cent beryllium and the remainder of copper is annealed and prepared for subsequent hardening by heating to 1400–1475 F, for 1 to 3 hr, and then quenching; it is hardened by reheating to 500–650 F for 1 hr and then either quenching or cooling in air. Alloys of beryllium show a tendency to anneal slowly if maintained at moderately high temperatures for a long time. Beryllium copper should not be exposed continuously to more than about 390 F, nor beryllium nickel to more than about 660 F. Where the metal has been extensively cold-worked, these temperatures must be lowered yet further.

Heat-treated beryllium copper shows remarkable characteristics. Tensile strength is raised from, say, 66,000 psi to 175,000 psi; by rolling before final heat-treatment, it can be made to show as much as 200,000 psi. Electrical conductivity is increased to as much as double. Owing to its good electrical conductivity (ranging from 18 per cent to as much as 30 per cent of that of copper), it is now being used quite extensively where the combination of high strength and good conductivity is required. Its hardness combined with its nonsparking characteristics have also resulted in the use of beryllium copper for edge tools where the sparks that might result from steel tools would prove a hazard. Table 4 gives the properties of pure beryllium as determined to date.

TABLE 4 CONSTANTS AND PHYSICAL PROPERTIES OF PURE BERYLLIUM[a]

Melting point, 2345 F (1285 C)		
Boiling point, 5036 F (2780 C)		
Coefficient of linear expansion, 0.0000068 per deg F		
Latent heat of fusion, 621.9 Btu per lb (345.5 cal per g)		
Specific heat, 0.425 Btu per lb per deg F at 68 F		
Coefficient of heat conductivity, 0.3847 cal/sq cm/cm thick/sec/deg C		
Thermoelectric potential to platinum, —0.16 mv (at 20 C)		
Electrical resistivity, 18.5 micro-ohm-cm		
Modulus of elasticity, 42,700,000 psi		
Weight, 0.0658 lb per cu in. at 68 F		
Specific gravity, 1.85 (this is most authoritative, various sources range from 1.82 to 1.85)		
Atomic weight, 9.02		
Color, white, resembling magnesium		
Atomic number, 4		
Hardness, about 100 Brinell		
Tensile strength:	Cast, 17,000 to 21,000 psi Forged, 27,000 psi	Elongation practically nil
Proportional limit: Forged, 8700 psi		

[a] Using most authoritative sources to December, 1943.

Experimental work has also been carried out on alloys of beryllium and aluminum with the expectation of producing a high-strength lightweight alloy that would exceed the performance of present aluminum alloys. While some success has been attained in this effort, the results have not yet been sufficient to permit commercial competition with the better known aluminum alloys. The outstanding feature of these beryllium-aluminum alloys is their high modulus of elasticity. "Beralite," an alloy consisting of about 35 per cent beryllium, shows a value for E of 21,500,000, as compared with figures around 10,300,000 for various aluminum alloys. Tensile strength approximates that of the strongest of the aluminum alloys, while specific weight is appreciably lower. Development of this alloy is seriously handicapped by the present high cost of beryllium but any radical drop in the cost of beryllium production might open up a market.

CEMENTED CARBIDES

This development represents one of the most revolutionary advances in the art of metal cutting. Cemented carbide was first used in Germany as a substitute for diamonds during the first world war, and some years after the war it was imported into the United States in the form of stock-sized bars that had to be ground to the required tool size. The real development of cemented carbides in the United States dates back to 1928, when the General Electric Company, after obtaining the right to make and sell cemented carbides in the United States, organized the Carboloy Company to undertake the development. Since that time, there have been numerous price reductions as well as vast improvement in the material and in its applications, and a tremendous extension of its use. Several producers of cemented carbides are now in operation in this country. Basically, cemented carbide begins with heating of powdered tungsten and carbon (at about 2650 F), which thus unite to form tungsten-carbide particles. The powdered carbides are then mixed with powdered cobalt, pressed into molds and semisintered to cement the hard carbide particles into a coherent metal having a hardness approaching that of the diamond. This material is then machined, ground, or otherwise formed and then fully sintered to make a practical cutting tool. By varying the amount of cobalt, varying degrees of hardness and toughness are attained; the greater the amount of cobalt, the less the hardness and higher the toughness. This original development was later extended by the addition of tantalum and titanium carbides to provide special characteristics to meet varying requirements. A line of cemented carbides is now available, varying slightly in individual characteristics, but all showing the following general characteristics:

1 Extreme hardness, approaching that of the diamond.
2 High red hardness.
3 High compressive strength.
4 Relatively low resistance to impact.
5 High wear resistance.
6 High resistance to many forms of corrosion.

In general, straight tungsten carbide is used for machining brittle materials like cast iron and low-strength materials like brass, copper, etc. Combined carbides are used for machining tough materials like steel.

The effect upon machining practices that resulted from the introduction of cemented carbides has been rather startling to say the least. This is vividly illustrated in the A.S.M.E. report on "High-Speed Milling Practice" as well as the numerous articles in trade journals. Using high revolutions and greatly increased feeds, milling is now being done without the use of any cutting fluid; sparks fly as with grinding and the chips are red-hot, although the work is not excessively heated. Negative rake is used on the cutting edge for certain applications such as milling steel where this form of edge was found desirable for carbide tools, as it reduces chatter and edge breakage. The rate of removal of material is quite often limited only by the horsepower available for delivery to the cutter. In cutting aluminum alloys, surface speeds of cutters have exceeded 10,000 fpm at feeds over 225 ipm; in some such cases production has been increased as much as 1000 per cent by the use of carbide cutters, combined with new operating technique.

Following the original application of cemented carbides to cutting tools, there came several other applications of this material. One is the use of cemented-carbide-tipped drills for drilling concrete, brick, and stone with the ordinary rotary electric drills in the same manner as wood or metal are drilled with straight fluted or twist drills. Cemented carbides are also being used for lathe centers, draw dies for wire, tube and sheet metal, some stamping dies, twist-drill tips, Brinell machine balls, gages, and other applications. Diamond-impregnated carbides are also being used for tools used in dressing grinding wheels. A saving in diamonds is claimed for the last applica-

tion mentioned. Cemented carbides also have been widely used in other applications where exceptional wear resistance or corrosive resistance is required.

POROUS-CHROMIUM SURFACING

The extremely hard and excellent wear-resisting properties of chromium have long been known. This element has one of the lowest coefficients of friction of any of the metallic elements and, in many cases, it has been operated under light load without any lubrication whatsoever. Hard-chromium plating is rated on the Moh scale as 9 as against 10 for the diamond. On the other hand, hard smooth chromium has the serious disadvantage of not retaining a good oil film. The Van Der Horst Corporation of America is responsible for a novel departure in the application of chromium to bearing surfaces which retains the advantages of chromium while permitting it to hold a film of lubricating oil. This process is marketed under the trade name of "Porous-Krome Process" and consists briefly of the following: The wearing surface is hard-chromium-plated, it is then placed in an acid bath and etched until the smooth surface has numerous tiny crevices or pores eaten into it. The etched surface is then washed clean and is ground and honed to remove the rougher high spots that result from the acid bath. The finished plate is relatively thick, ranging up to 0.030 in., and it has a smooth and very hard surface with innumerable microscopic crevices which serve the purpose of retaining the lubricating oil. This finish has been extensively applied to internal-combustion-engine cylinder walls, piston rings, etc.

DIE-CASTING MATERIALS AND PRACTICES

Advances in die casting have taken the form of improved alloys, improvement in physical properties of casting for the same alloys by better knowledge of die design, and improved physical properties for the same alloys by increased casting pressures. A fairly recent addition to die-casting materials was made when some magnesium alloys became available. Studies of the effect of die design which were made by the New Jersey Zinc Company showed that, for the same chemical composition, the impact strength of zinc alloys could be more than doubled, tensile strength slightly increased, and elongation and hardness simultaneously increased by improved proportioning of gates, vents, and overflow wells; the gain being due entirely to the production of sounder castings. Casting pressures which formerly ranged from 400 to 2000 psi, depending upon alloy and size of casting, have recently been run up to as much as 15,000 to 25,000 psi for aluminum or magnesium alloys and small pieces. Due to machine limitations, the tendency is to use lower unit pressures for larger castings of the light-metal alloys.

Extended aging tests, ranging up to 7 years, which were made on some of the commonly used zinc-base alloys show that they tend to lose a small proportion of their tensile strength but to gain in ductility after several years at room temperatures. The introduction of lead-base casting alloys was a wartime development to relieve shortages of other metals. These alloys do not equal the strength and hardness characteristics of the zinc-base and aluminum-base alloys but some have been developed which are inexpensive and sufficiently hard for certain uses. Lead-alloy casting metals are now available which will show tensile strengths up to 11,000 psi and Brinell hardness up to 22. During the wartime shortage of other metals, some of these were used for such purposes as small V-belt pulleys, plumbing traps, parts, and fittings, etc.

Zinc-Alloy Die Material. Under the trade name of "Kirksite-A," a zinc alloy was marketed in 1939, for application to blanking and forming dies for short-run production. This material has been found to be very practical for the aircraft industry and is now in use by nearly all of the aircraft manufacturers in the United States. Its chief applications are (*a*) blanking dies for moderate runs, (*b*) forming dies for large parts from relatively thin metals, and (*c*) molds for plastics. The advantages are saving of cost over the use of a steel or cast-iron die, ease of casting, machining, and finishing off, as well as the fact that the material can be remelted and reclaimed with a loss of only a small percentage of the metal. Very general use is being made of this alloy for forming airplane cowling of sheet aluminum; use is also being made for blanking aluminum and forming some harder materials like Inconel and stainless steel.

The alloy consists chiefly of zinc with some aluminum, copper, magnesium, and traces of other metals. The physical characteristics of interest are melting point 717 F, tensile strength (cast) 37,800 psi, (rolled) 62,000 psi, compressive strength 60,000 to 75,000 psi, hardness 100 Brinell.

The most general practice in using this material for blanking dies is to make the punch of steel as usual, rough out the die from rolled Kirksite, cutting it slightly undersize, and then use the steel punch to shave it to the finished size. In applying Kirksite to forming operations, the usual practice is to make plaster patterns and cast the alloy in sand, although some small dies are cast in plaster molds. For some runs, the punch is made of antimonial lead, or rubber, depending on the kind and thickness of metal, length of run, and severity of deformation; for long runs, thick metal, or deep draws, Kirksite is used for both punch and die.

TIN AND LEAD COATINGS ON STEEL

When the shortage of tin developed as a result of the interruption of our chief source of supply, one of the first developments was the use of a greatly reduced thickness of tin coating for the steel sheet used in the manufacture of food containers. It was found that the normal thickness of about 0.00008 in. could be reduced with safety to as little as about 0.00005 in. by the process of electroplating the tin on the steel instead of the hot-dip method, and then heating the plated metal to fuse and completely unite the tin coating.

The use of lead-rich alloy coatings is now prominent; although precluded from food containers because of the toxic compounds formed by lead in contact with foods, this type has many other applications. Coatings of as high as 95 per cent lead and 5 per cent tin have been used successfully as a protective coating for steel by the hot-dip method. Coatings with as little as $2\frac{1}{2}$ per cent tin are now widely used. The use of lead coating for steel is, of course, very old but the former terneplate coatings contained a much higher percentage of tin; usually from 18 to 25 per cent. Reduction of the tin content was made possible by improved coating technique and the development of anhydrous fluxes for cleaning the metal. Lead-rich-alloy-coated steel can be die-formed to a considerable extent without destroying the protection, the lead content actually serving as a lubricant in the forming operations. Lead coating also has the advantage of providing an excellent base for paint.

TINLESS SOLDERS

As a result of the serious reduction of the tin supply which resulted from the war situation in the Pacific, considerable effort has been expended either to reduce drastically or eliminate entirely the tin content of soft solders. One of the avenues of approach has been that of utilizing silver, of which an ample supply exists, although the relatively high cost limits the extent to which it can be used as a substitute for tin. One alloy of this type consists of approximately 97.5 per cent lead and 2.5 per cent silver. It has the disadvantage of somewhat higher cost as well as the rather serious one of a higher melting point. Other rather serious disadvantages are its tendency to oxidize at the melting point and its poor "wetting" characteristics, as compared with 50-50 tin-lead solder. Some more promising alloys have been those which do not completely eliminate but merely reduce the amount of tin, replacing the difference with lead and bismuth or other metals. Still another avenue of approach led to the use of arsenic or the combination of arsenic

and antimony, but these solders have not come into common use.

The net sum of the various investigations appears to be that there is no low-tin solder that fully equals the all-round working characteristics of the "50-50" and other prewar high-tin solders but there are some very practical compromises. Some typical comparisons are given in Table 5.

SILVER BEARING AND OTHER BABBITTS

Just as the wartime shortage of tin affected its use in solders, this also had a most important influence on babbitts. The most obvious means was, of course, to increase the lead content but this had to be counteracted by the addition of some hardener in order to make the new babbitt stand up under service loads. Investigation along these lines was carried out by the Battelle Memorial Institute and some of the white-metals producers. As a result of the work at Battelle, an alloy was produced containing $2\frac{1}{2}$ to 5 per cent of silver, 10 to 15 per cent of antimony, 2 to 5 per cent of tin, with the balance of lead. The silver content provided the same temperature-hardness relations as were found in the prewar tin babbitts, while the small tin content provided corrosion resistance.

This alloy has greater strength, ductility, and bendability than the lead babbitts; it also possesses greater resistance to squeezing out at elevated temperatures, which permits its use in applications where the lead babbitts could not be employed. Tests on bearings run dry indicated that the tin-base babbitts might run slightly longer than the silver-lead babbitts but that the latter were equal in every other respect. Because of the small amounts of silver required, this new babbitt material can be produced for less than the cost of tin babbitts. Based on 1941 prices of the metals, the tin babbitts cost around 45 to 50 cents per lb, which compares with 21 cents for an alloy containing 2.6 per cent silver, and 33 cents per lb for an alloy containing 5 per cent silver.

COPPER-BRAZING METHODS

While copper brazing, in controlled-atmosphere electric furnaces, has been in common use for many years, recent investigations have brought attention to bear upon some hitherto unexploited advantages. As a result of this, a special technique has been developed by which copper-brazed joints in steel parts can be produced which show surprising strength. The strength of a properly made joint exceeds the shearing strength of the copper, and it has even been found, in a few instances, to approach or equal the shearing strength of the steel. Explanation of this is furnished in two ways: (*a*) Examination of joints under the microscope indicates that the copper forms an alloy with the iron instead of merely filling surface interstices; (*b*) tests made on joints subjected to the heating cycle but without spelter indicated that the surfaces of the steel "grow" together during the heating.

In order to attain these results it has been found necessary to make the steel pieces extremely tight-fitting, and to leave (apparently) no space for the copper to flow into. Press fits were found to produce distinctly better strength values than loose joints, and clearance is distinctly inadvisable, although joints with a clearance of 0.003 in. have developed shear strength above that of the spelter in some cases. Due to the very high "wetting" action of liquid copper on steel, a very pronounced capillary action takes place; the copper becomes sucked into the most infinitesimal space between the steel surfaces. H. M. Webber, of the General Electric Company, recommends a press fit of 0.001 in. per inch of diameter for most copper brazing. Experience showed that the liquid copper would climb vertically upward, alloying with the press-fitted surfaces, the height of climb being mainly a function of time. Providing sufficient time was allowed, the copper could be counted upon to creep to practically any height. The copper may be applied in the form of powder, 150 mesh, or suitably proportioned washers, wires, etc.

LAMINATED METALS

The laminated metals may be divided into the three groups of (*a*) those metals which are surfaced with other metals for protection against corrosion, (*b*) those metals which are laminated for the purpose of producing thermostatic response, and (*c*) those laminated for electrical applications. Prior to the period covered by this paper, the Lukens Steel Company started production of sheet steel, ranging from $\frac{3}{16}$ in. up to heavy plate, faced with nickel, monel, inconel, stainless steel, and silver. The rolling of high-strength aluminum alloys with a surfacing of commercially pure aluminum to increase their corrosion resistance has also been in vogue for so many years that it does not warrant more than mention here.

This practice has recently been extended to some other combinations. One is "Armco aluminized steel," which consists of soft steel sheet (either regular low-carbon or "copper steel") upon which a surface layer of essentially pure aluminum is obtained by the hot-dip method. The strength and low cost of steel is thus combined with the special advantage of aluminum. This combination also seems to have good resistance to corrosion by heat. It will withstand temperatures up to 900 F, without discoloration and, even where it finally discolors, it

TABLE 5 COMPARISON OF SOFT SOLDERS[a]

No.	Tin	Lead	Antimony	Silver	A Liquidus, in deg F	B Solidus, in deg F	A–B Pasty range, in deg F	Uses
1	50	50	...	...	421	361	60	High-grade solder for general purposes
2	35	63	2	...	459	363	96	Wiping solder and substitute for 50–50, but not recommended for use on galvanized iron
3	35	65	...	...	477	361	116	On galvanized iron and places where higher soldering temperature can be tolerated
4	15	84.5	0.5	...	543	361	182	For dip-soldering of radiators, coating of metals, machine-soldering, etc.
5	3	97	...	...	603	594	9	For body solder, coating of metals, machine-soldering
6	..	97.5	...	2.5	579	579	0	On copper, brass, etc. with torch-heating

[a] Data published through courtesy of the National Lead Company.

Notes:
Solder No. 1 can be applied by any method; iron, machine, torch, or dipping, except wiping.
Solders Nos. 2 and 3 can be applied by any method.
Solders Nos. 4, 5, and 6 can best be applied by torch, machine, or dipping.

will not scale at temperatures well above 1000 F. It is now being used successfully for such applications as mufflers of internal-combustion engines. The advantages in other cases will be more obvious since aluminum shows good corrosion resistance to many acids and other corrosive liquids. The high reflecting power of aluminum for light and heat is also utilized in some applications of this metal. The adherence of the two metals is excellent and sufficient to permit even moderate forming and drawing without destroying the surface or causing separation of surface material from base. The aluminum-coated steel can be welded successfully, provided that appropriate technique is used.

Another application of laminated metals is used by some makers of bronze bearings in producing steel-backed, bronze-and-graphite-faced bearings. Bronze bar is powdered, mixed with graphite, sintered, and applied to a steel base to form a flat laminated sheet which is then cut and formed into bearing bushings.

Another laminated-metals development of the past few years is a clad steel sheet or strip, marketed under the trade name of "SuVeneer." This development was inspired chiefly by the wartime shortage of copper, and the need for conservation of this metal; its first application was the coating of steel sheet with a thin layer of high-copper brass for drawing into small-arms bullet jackets. Firing tests having shown the clad bullet to have greater penetrating power than solid-jacket bullets; this application is likely to remain. The Superior Steel Corporation, as a result of its experience with this clad steel for bullets, is now marketing a variety of clad metals, including steel clad on one or both sides with copper, several types of brasses and bronzes, nickel, monel, and several types of stainless steels. This material is available with certain combinations of facing materials, one on one side and a different one on the other in equal or unequal thicknesses. The bond between the facing metals is mechanically inseparable. Thus, if the core is soft steel, the laminated sheet or strip can be formed and deep-drawn with no risk of separation. If the core is of high-carbon steel, the material can be heat-treated and hot-formed like solid metal.

In the thermostatic group of new laminated metals, Chace No. 6650 warrants mention. This is a new bimetal, introduced about 1942, which has exceptionally high thermal activity (about 30 to 40 per cent more than that of previous bimetals) and high electrical resistivity. It is recommended for use within a temperature range of —50 to 500 F, and, for uniform temperature range and the same weight, it is capable of 63 per cent more work. Another bimetal, Chace No. 6850, has 30 to 40 per cent greater electrical resistivity than previous bimetals. This material is recommended for —100 F to 500 F range. Also developed in the past few years are the copper-faced and silver-faced aluminum and aluminum alloys marketed by the general plate division of Metals and Controls Corporation under the trade names of "Alcuplate" and "Alsilplate." Chief advantages are low specific gravity combined with good conductivity, the latter applying especially to high frequencies.

HIGH-NICKEL ALLOYS

A nickel alloy, introduced in 1936, as "Z" nickel, possesses the corrosion-resistant and heat-resistant characteristics of commercially pure nickel, but is capable of responding to heat-treatment and showing exceptionally high tensile strength. This alloy contains about 98 per cent nickel, and its tensile strength ranges from 90,000 to 200,000 psi, depending upon the amount of cold-working. By heat-treating the cold-worked material, this can be raised to as much as 250,000 psi. This material considerably exceeds monel in strength; in corrosion resistance it is inferior for certain types of exposure, and superior for others.

Another high-nickel alloy, introduced in 1935, as "K" monel, is a development from the original 67-28 per cent nickel-copper alloy marketed for many years under the trade name of "Monel." The new alloy resulted from the discovery that the addition of a small proportion of aluminum rendered the earlier alloy responsive to heat-treatment. "K" monel consists chiefly of 66 per cent nickel, 29 per cent copper, and 2.75 per cent aluminum. Tensile strength ranges from 90,000 to 165,000 psi, depending upon the extent of cold-working; by heat-treating the cold-worked material, this can be increased to as much as 200,000 psi. This alloy possesses all of the exceptional corrosion-resistant characteristics of the original monel; it also retains both its strength and corrosion resistance very well at elevated temperatures. At very low temperatures it shows an increase in both tensile strength and ductility. It is nonmagnetic down to very low temperatures, the Curie point being —150 F or lower, depending upon the condition and heat-treatment.

"LOST-WAX" CASTING OF METALS

The "lost-wax" or "investment" method of casting is actually one which was common a few centuries ago but had fallen into disuse and thus became a lost art. It was recently revived for application to castings where close tolerances were required. Jewelry, dental applications, and some similar cases were the first recent applications, but it has since been extended to a wide variety of casting where close tolerances must be held. The method consists basically of (*a*) molding a wax pattern for each individual casting; (*b*) forming around this a plaster cast of some refractory material; (*c*) after this cast has set, heating the mold thus formed to flow the wax out; and (*d*) using this mold for the molten metal. For low-melting-point alloys, plaster of Paris can be used for the mold; for higher-melting-point alloys more refractory materials like silica are used. The process has to be repeated for each piece since the cast mold must be destroyed to remove the casting.

The advantage of this method is its greater accuracy; it permits a higher degree of precision than is possible with any other method of casting except the die or permanent-mold types. It is claimed that, with the smaller castings, dimensions can be held to within 0.002 in. by this means. While not necessarily a part of the method, it has been found convenient to apply pressure when casting by the "lost-wax" method; this is sometimes accomplished by the use of centrifugal force during casting and at other times by applying compressed air immediately after pouring. One of the outstanding applications of the process has been in the casting of airplane supercharger turbine buckets, which involved use of an alloy with a melting point of about 2500 F.

CALCIUM

Compounds of calcium have been marketed for many years, and metallic calcium was produced in France and Germany more recently, but its production in the metallic form in the United States dates back to about 1939. Since the metal is not new, the chief interest in this development is due to the reduction in price which warrants reconsideration in the light of a material that cost $20 per lb in 1920, but is now available for less than $2 per lb. This, of course, is likely to open new applications, and hence the justification for its review in this paper.

Calcium metal is used as a deoxidizer and cleanser in the manufacture of the highest-quality steels which must pass rigid cleanliness specifications, and to improve the hot-working characteristics of a number of the high-alloy steels. It is used as a reducing agent in the preparation of pure metals such as beryllium, titanium, and zirconium. In the magnesium and aluminum industries it is used variously as an alloying agent, to simplify casting operations, and to speed up heat-treating cycles. It also has proved valuable as a hardener in lead alloys used for bearing metals and cable sheaths. Still other uses are for the debismuthing of lead, and in some copper-aluminum alloys it is used in fractional percentages to prevent hot-

shortness. Its effect as a hardener in lead is most pronounced; and it increases the fatigue life of lead remarkably.

Metallic calcium is very light (specific gravity 1.54), and fairly soft, being only slightly harder than lead. It reacts with water somewhat like but less vigorously than sodium, hence it requires protection from moisture. Table 6 gives some of the physical constants of this element.

TABLE 6 SOME PHYSICAL CONSTANTS OF CALCIUM

Ultimate tensile strength distilled metal, psi	6050
Ultimate tensile strength drawn wire, psi	8700
Modulus of elasticity in tension, psi	3200000 to 3900000
Hardness, Brinell, 17 (500 kg)	
Hardness, Moh's, 2.5	
Melting point, 1490 F; oxidizes rapidly starting at 500 F, boiling point, 2138 F	

INDIUM

The element indium was discovered in 1863, isolated later, and for many years was produced only in infinitesimal quantities as a laboratory experiment. Starting about 1924, efforts were made to find some means by which the metal could be produced on a commercial basis. As a result of this the price, which was around $3800 per troy lb in 1924, had been brought down to about $72 per troy lb for 99 per cent purity in 1944, thus opening commercial possibilities for the metal. It is at present produced by extraction from the flue dust of zinc refineries but some ores have been located which show promise of development. So far production has been confined mainly to the United States, with small quantities indicated in ores in Belgium, Germany, and Japan.

The development of this metal is so recent and the price is still so high that its possibilities have not yet been fully explored. One of the first uses was in dental casting alloys where small percentages were found to improve corrosion resistance, hardness, and strength. Another application was found in the use of fractional percentages to improve wear resistance and corrosion resistance of copper-lead and cadmium-lead bearing metals.

The most recent application is the rather unique plating process used for extending the life of bearings. This is already used extensively in aviation engines and is applied as follows: The bearing shell is plated with a layer of silver, upon which is plated a layer of lead. A thin layer of indium is then plated on the lead, after which the part is moderately heated. The heating causes the indium to become diffused into the lead, uniting with it to form a hard alloy surface which greatly increases the bearing life. Table 7 gives some of the physical properties and constants of indium as determined to date. The pure metal is very soft, has a very low melting point, and is highly corrosion-resistant. It is a fair conductor of electricity, about 20 per cent of that of copper, and has an exceptionally high coefficient of thermal expansion, being about twice that of copper.

LITHIUM

This is the lightest of the metals and is one of those elements which, although known and used for years in the form of salts, was not produced as a metal until the first world war. The element was discovered in 1807, first isolated in 1817, and its first use as a metal on a commercial basis was about the end of the last war, when a German company used a fractional percentage in an aluminum-zinc alloy. Since then it has been used on a larger scale as a hardener in lead-base bearing alloys. Within the past 10 years or so, the commercial production of lithium has been started in the United States. Several years ago it was greatly expanded and is now on a substantial commercial scale, the recent growth justifying its inclusion in this paper. Current chief use of metallic lithium is in master alloys (introduced within the past 10 years) and in compounds made from the metal. These master alloys are used in metallurgy

TABLE 7 SOME PHYSICAL CONSTANTS AND PROPERTIES OF INDIUM

Atomic number, 49
Density, 7.31(0.264 lb per cu in.)
Melting point, 311 F
Boiling point, over 2642 F
Electrical conductivity at 20.9 C, 9.06 microhm cm, 19 per cent IACS std.
Coefficient of thermal expansion, 0.0000183 deg F
Coefficient of thermal conductivity, 0.057 cal/cm²/cmdeg/C/sec
Specific heat, 0.0568 cgs units
Tensile strength, 430 psi
Hardness, Vickers, 1

because of the exceptionally high affinity of lithium for gases and nonmetallic impurities. Master alloys are now available of lithium in combination with one or more of the following metals: aluminum, copper, lead, magnesium, manganese, nickel, silicon, tin, and zinc. Commercial lithium ranges from 98 to 99 per cent pure. Another application advocated for lithium is in heat-treating, where it can be used in the furnace to produce a nonoxidizing atmosphere.

One of the outstanding characteristics of metallic lithium is its readiness to combine with other elements; this quality makes it useful in metallurgy (as just noted) but renders it unsuitable for engineering applications in the pure state. Lithium decomposes water as do the other alkali metals but without the violence and hazard of explosion encountered with sodium. As an alloying element, lithium has a tendency to harden and strengthen the matrix in low-melting-point metals, especially aluminum and lead. As a result of its pronounced tendency to form intermetallic compounds with many other metals, high additions of lithium often result in embrittlement of the alloy. Thus despite the intriguing fact that lithium weighs only a little more than half as much as water, it does not offer promise as the base metal of an ultra-lightweight alloy. However, it has been found exceptionally valuable in producing high-conductivity copper, where it removes both oxygen and hydrogen; only a trace of the lithium itself is left in the copper.

From the viewpoint of the design engineer, lithium is of chief interest as providing a means of eliminating most of the defects usually encountered in castings of many types of metal. Another feature of lithium is its exceptional transparency to X rays, which pass through it like visible light through glass. Table 8 gives some of the physical constants of this element.

TABLE 8 SOME PHYSICAL CONSTANTS OF LITHIUM

Atomic number, 3
Density, 0.53.
Melting point, 366.8 F
Boiling point, 2435 F
Electrical conductivity, about 1/8 that of silver
Coefficient of thermal expansion, 0.0001801 per deg C
Hardness, Moh's, 0.6

(*To be continued*)

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Innovations in Agriculture

(*Continued from page 184*)

They are used not only with hay, but with bundled grain, and even sugar beets. Around 400 more or less improvised sugar-beet harvesters were used in one state. Home-made elevators have been made for grain, and for loading hay bales, sacks of grain, and even barrels of potatoes. In Illinois, the farmers, with very little help from the manufacturers, have converted a corn picker into a machine for snapping ears of sweet corn. A digger that sacks the potatoes also seems to be on the way.

The implement makers have been too occupied with other things to give their usual attention to such problems. But they have continued their work on cotton picking and other cotton equipment and have developed the new devices for splitting sugar-beet seed, for high-speed spraying, and several other purposes. A good suggestion for any implement maker at this time is that he send out some good field men to gather in all the new ideas they can that have grown out of the experience of the farmers in trying to get their work done without their usual hired help.

AFTER THE WAR

The same conditions that have retarded mechanization of farm operations in the past will operate after the war, but not altogether in the same way or to the same extent. The tasks on farms will continue to be much less repetitive than in factories or even in stores, much of the equipment will be used only a few weeks each year, and the machines will need to be brought to the work and not contrariwise as in factories. But these handicaps will gradually prove less impeditive. Units too small to use machines efficiently will continue to abound, but these will gradually become less important both because of the consolidation of small units and because of the development of smaller machines. Surplus farm workers are likely to move to other occupations more freely.

Such changes as these are long-run in their effects. They are hastened a little in some decades and delayed in others. The decade after the war is likely to see them hastened, as did the decade after the last war. Much more important will be the changes of a more revolutionary nature induced by the combination of higher farm wages, probable continuing labor "shortage" for at least a year or two after reconversion, strong farm-buying power at the time that farm machinery becomes freely available again, and important new or improved types of equipment like corn pickers, hay balers, field forage choppers, and most important of all, the cotton pickers. The setting is right for very rapid advances after the war. How rapid they will be, and especially how sustained they will be, is dependent upon the level of employment in the cities, and upon the level of farm incomes.

ROAD MAPS TO FREEDOM[1]

By PAUL PIGORS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

WITH the end of the European war in sight and during a time of political uncertainty and confusion, it is essential that we should clearly picture our present opportunities and dangers. Though military victory had to be our first aim, we must realize that in itself this will not provide a positive solution for our political and social problems. As pointed out by Professor Hayek, to win the war "will only gain us another opportunity to face the basic problems and to find a way of averting the fate which has overtaken kindred civilizations."

To stress the difficulties before us is not to underestimate the opportunity for choice that victory will give us. But we shall not be worthy of this freedom, purchased at such a high price, unless we make every effort intelligently to prepare ourselves to make the necessary decisions. Such preparation must be twofold. Among the various possibilities that offer, we must see clearly where each choice will lead us. Then with different objectives before us we must resolutely choose the road we want to take. The unforgivable sin toward those whose sacrifices have won for us this freedom of decision would be not to make full use of it by going forward, but instead to attempt to go backward in the direction of the "good old days." On the other hand, it will not be sensible to fix our eyes so far ahead on an idealistic future that we fail to mark the milestones as we pass them.

Two current books[2] are helpful to us in taking our bearings. These are: Friedrich A. Hayek's "The Road to Serfdom," and Manya Gordon's "How to Tell Progress From Reaction: Roads to Industrial Democracy."

TRAGEDY OF GERMANY

Professor Hayek, an internationally famous economist (Austrian by birth and a naturalized British subject) has taken full advantage of the priceless opportunity afforded by twice living through a similar evolution of ideas in different countries. To him, the supreme tragedy of modern Germany is that "it was largely people of good will, men who were admired and held up as models in the democratic countries, who prepared the way for, if they did not actually create, the forces which now stand for everything they detest." In his opinion, "the rise of fascism and nazism was not a reaction against the socialist trends of the preceding period but a necessary outcome of those tendencies." We, therefore, should pause to consider whether some of the ideals we now cherish may not lead us into the very dangers from which we are now fighting to save ourselves.

To throw light on this difficult question, Professor Hayek makes a useful distinction between socialism as a *goal* and certain *methods* which are commonly accepted as inherent in socialism. All socially reponsible individuals can easily agree on the desirability of such ends as social justice, greater equality of opportunity, security, and the basic freedoms. But there is considerable difference of opinion as to the means by which these ends are to be attained. Most socialists stress such methods as "the abolition of private enterprise, of private ownership of the means of production, and the creation of a system of 'planned economy' in which the entrepreneur working for profit is replaced by a central planning body." The question to be asked is: Will the methods used help us to attain our goal or will they gradually lead us in the opposite direction? According to Professor Hayek the trend toward increased state planning and government control leads us away from the road to freedom. And while we must all agree that in times of total war the exercise of central authority is necessary, we should not accept such centralization of authority as a useful method for a world at peace. In searching chapters, outstanding among which are: "The 'Inevitability' of Planning," "Planning and Democracy," and "Planning and the Rule of Law," Professor Hayek differentiates between "planning" which furthers the aim of creative individualism and "planning" that ends in the arbitrary assertion of authority on the part of a central planning board and the shackling of all individual freedom.

COMPLEXITY MAKES CENTRALIZED CONTROL INEFFICIENT

It is commonly supposed that the complexity of modern industrial civilization makes central planning a necessity. Actually, this very condition makes centralized control inefficient, since no single individual or board can grasp all the relevant facts. Decentralization has thus become essential. Unity of action can best be attained through co-ordination of individual decisions, based on the communication to each agent of the facts that he must know in order effectively to adjust his decisions to those of others. Professor Hayek makes an excellent case for creative individualism and clearly traces the unfortunate consequences of planned economy, however idealistically undertaken. He sums up his argument as follows: "Our freedom of choice (as consumers) in a competitive society rests on the fact that, if one person refuses to satisfy our wishes, we can turn to another. But if we face a monopolist we are at his mercy. And an authority directing the whole economic system would be the most powerful monopolist conceivable."

Manya Gordon's book offers strong support to Professor Hayek's thesis because she reaches similar conclusions by a somewhat different method. She begins with a careful survey of Utopian literature such as that by Plato, More, and Campanella, and finds that beneath their collectivist theories, none of them really believed in democracy as we use the word today. Next she shows that in actual experiments, nearer to our own time, the tendencies which were latent in this Utopian literature resulted in autocratic self-assertion by the leaders.

CONTEMPORARY EXPERIMENTS IN SOCIALISM

The major part of Miss Gordon's book is devoted to the study of contemporary experiments in socialism. The United States Post Office, for instance, is usually taken as a model of socialized service. Realistic observation, however, reveals that as employers, political officials are just as exacting as private individuals and often more autocratic, expecting that, as servants of the state, the employees should forego their rights as members of organized labor. This tendency of governments to subordinate the rights of individuals appears clearly even in Soviet Russia, where the Sixteenth Congress of the Communist party in 1930 bluntly stated that in a socialist community, workers must abandon their trade unionism. Miss Gordon is well aware of the circumstance that the industrial activities of Soviet Russia were, at that time, partially

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[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] "The Road to Serfdom," by Friedrich A. Hayek, University of Chicago Press, 1944, 250 pp. "How to Tell Progress From Reaction: Roads to Industrial Democracy," by Manya Gordon, E. P. Dutton & Company, Inc., New York, 1944, 320 pp.

dominated by a war psychology. But she feels that this is not the basic reason for the authoritarian trend. She finds that there is overwhelming evidence that the communist state constantly stresses not the autonomy of the workers but the arbitrary power of the industrial dictator. For this reason, she thinks that the Soviet Union will cease to be a leader in social reform.

Unlike Professor Hayek, Miss Gordon approves of some contemporary experiments in socialization. She finds encouragement in the rapid development of the co-operative movement. Furthermore, she believes that the activities of the Tennessee Valley Authority, as presented in Mr. Lilienthal's "Democracy on the March" (1944), set the pattern for a genuine social experiment in democratic public ownership. She finds equally inspiring examples in the British public corporations, as exemplified by the London Transport Board, the Central Electricity Board, and the British Broadcasting Corporation. These are owned by the public, and the former owners do not participate in managing the corporations. "The function of these corporate bodies is not merely regulation or supervision but production of a commodity or service. The important difference between this new method of socialization and the old schemes of nationalization . . . . is the separation of politics from economics. Employees of these corporations are not considered civil servants but as workers who have full trade-union status."

Both Professor Hayek and Miss Gordon point out how important it is that we decide clearly and promptly where we want to go and how we mean to get there. Both books demonstrate that many of the signposts marked "socialism" and "road to equality" do not lead to freedom. They conclude that it is unsafe to trust ourselves to doctrinaire "road maps" or to harbor preconceived notions as to our whereabouts. If we really want to know where we are going, we must be guided by the compass of common sense and by our actual observation of conditions at each stage along the way.

SECOND REPORT ON THE AMERICAN PATENT SYSTEM[1]

By A. A. POTTER

DEAN OF ENGINEERING, PURDUE UNIVERSITY; EXECUTIVE DIRECTOR, NATIONAL PATENT PLANNING COMMISSION

UNTIL recently, information as to the patents or rights under patents held by the Government was confined to the several Government agencies which acquired them. Realizing that there existed among these and other agencies a need for an adequate central source of information, the Commission recommended that a complete record of all rights and interests of the Government in or under patents and applications for patents be maintained in the United States Patent Office. The establishment of such a register was directed by executive Order No. 9424 of February 18, 1944, and the work of registration is nearing completion.

MAJOR CONCLUSIONS

The major conclusions of the Commission in its Second Report follow:

1 Enemy-owned patents seized by the Alien Property Custodian are outside the scope of the Second Report of the Commission. The ultimate management of these patents should be left until the return of normal conditions and the disposal of war problems.

2 The general policy of the Government should be that of making its patented inventions available for commercial and industrial exploitation by anyone, but the Government should have the power to grant exclusive licenses or otherwise dispose of patents under appropriate conditions and safeguards whenever it is determined that such action is necessary to assure the commercial development of an invention of a Government-owned patent.

3 The policy regarding the respective rights in employee inventions is not susceptible of rigid rules prescribed in advance for all departments but should be a matter primarily for departmental treatment. With respect to the two extreme cases, first—when an employee is hired to invent, and second, when an employee makes an unrelated invention, by use of his own time and facilities, the rule of the general law should be followed. General regulations should be maintained or promulgated in departments confronted with substantial patent problems.

4 The ownership of inventions resulting from research contracts cannot be determined in advance by an arbitrary or fixed rule but must be decided in each instance in accordance with the facts involved. The Commission believes, however, that since the Government has no need of the right to exclude conferred by a patent and does not enter into ordinary commercial enterprises in competition with its citizens, full ownership of patents should not ordinarily be asserted by the Government. An exception to this policy would be the situation in which private ownership of the patents would conflict with national interest. In those cases in which the Government does not acquire ownership of the patents, it should ordinarily receive as a minimum a royalty-free license.

5 There should be a central control body, in the Executive Office of the President, having the following principal powers, functions, and duties:

(*a*) Supervising and approving departmental policies regarding employee inventions, and determining disputed cases.

(*b*) Supervising and approving the manner of disposing of patent rights by the individual departments, including granting exclusive licenses and selling Government-owned patents.

(*c*) Instructing and advising departments and agencies, collecting information, conducting investigations, and making appropriate recommendations.

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[1] On Dec. 12, 1941, the President of the United States of America, by Executive Order No. 8977, created the National Patent Planning Commission "to conduct a comprehensive survey and study of the American Patent System." The first report of the Commission, transmitted to the President on June 9, 1943, was summarized by Dean Potter in MECHANICAL ENGINEERING, August, 1943, page 564. A more detailed discussion of the first report was presented by Dean Potter in an address to the A.S.M.E. Louisville Section and was published in MECHANICAL ENGINEERING, January, 1944, pages 15–20.

Dean Potter's present article is an abstract of the Second Report of the National Patent Planning Commission, "Government Owned Patents and Inventions of Government Employees and Contractors," released by the President on Jan. 9, 1945, and printed as House Document No. 22, 79th Congress, first session.

The members of the National Patent Planning Commission are: Charles F. Kettering, chairman, Chester C. Davis, Francis P. Gaines, Edward F. McGrady, and Owen D. Young. A. A. Potter is executive director and Conway P. Coe, U. S. Commissioner of Patents, is executive secretary of the Commission.—EDITOR.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Viscosity-Temperature Coefficient

To the Editor:

In Mechanical Engineering for November, 1944, page 739, Mr. Donald F. Wilcock proposes to replace the presently used "viscosity-index" and "A.S.T.M.-slope" viscosity temperature function indexes by a formula: "Index" $= 1 - \eta_{210}/\eta_{100}$. The advantages claimed for this new index are: Independence from absolute value of the viscosity within any one group of oils, and, therefore, "true" indication of viscosity temperature behavior of oils, specifically hydraulic oils. Both claims are unfounded, for the following reasons:

1 Within any one group of oils or homologous series of hydrocarbons, the ratio of the viscosity at 100 F to the viscosity at 210 F increases steadily with increasing absolute value of the viscosity, say at 100 F, of each oil or compound. Mr. Wilcock's index would, therefore, be even more dependent upon the absolute value of the viscosity of the materials in question than any of the existing indexes.

2 Due to the use of the ratio $\eta = 10/\eta_{100}$ this index overemphasizes differences in slope of the viscosity/temperature curve of oils with very "flat" curves while marked differences in slope of the usual grades of lubricating oils are hardly noticeable.

Attention is directed to the fact that there is a viscosity function already in existence (and in common use in several foreign countries), which is essentially independent of the absolute value of the viscosity of the oil in question. This is the "viscosity pole height" (VPH) discovered by Ubbelohde[1] and Walther. These workers found the viscosity curves of any one group of oils (such as Pennsylvania oil) to converge outside the ordinary (log-log centistoke + 0.8 versus log absolute temperature) chart in the point, the height of which over the abscissas was characteristic for each group. They expressed this height in the units of the ordinate (log-log centistoke + 0.8) and called it "viscosity pole height" (see Fig. 1, herewith).

The writer made an extensive study[2] of the properties of the VPH and found:

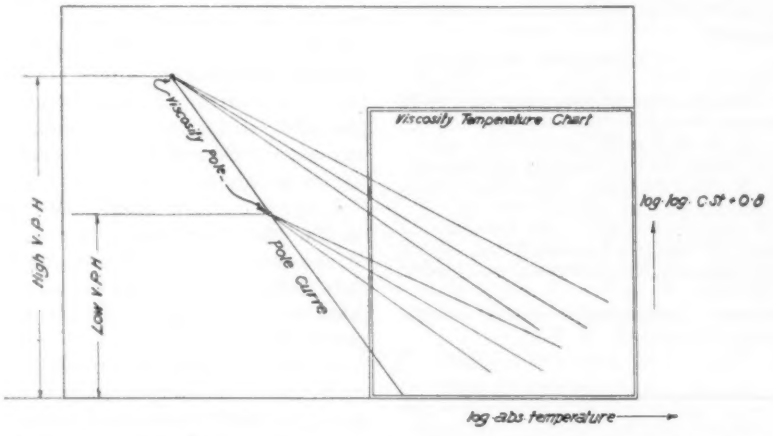


FIG. 1 DIAGRAM SHOWING VISCOSITY-POLE-HEIGHT SYSTEM OF UBBELOHDE & WALTHER

The VPH is a group constant for polymer homologous materials over wide ranges of viscosities. For many crude oils, the VPH is a constant (characteristic of the crude) over the entire range of ordinary lube cuts. There are, however, numerous crudes for which this statement does not hold (apparently because the components of the cuts vary not only as to boiling point, but also as to chemical character). Within the range of commercial lubricating oils (VPH 1.8 to 4.0, which is approximately equivalent to V-J 100 to 0), the VPH is arithmetically additive in mixtures. The VPH can be determined very easily graphically, either on the A.S.T.M. or Ubbelohde chart, or on a nomograph developed by M. Groff of the French Texaco. All this, as well as the fact that this index is already in widespread use, would speak in favor of adoption of the VPH.

The VPH has, however, a number of shortcomings, as follows:

1 Its existence cannot be explained on the basis of any of the proposed theories of viscosity.

2 It can be observed in only one choice of co-ordinates. If centistokes are replaced by any other absolute viscosity units, such as stokes or poises, etc., the resulting co-ordinate system will not give convergence of viscosity curves in the manner of the centistoke system.

3 Substances showing a steeper slope than the pole curve have negative meaningless value of VPH (not occurring as lubricants).

4 Liquids with zero, or nearly zero, slope viscosity/temperature curves can, of course be much better characterized by the slope (tan α) of their curve than by their VPH, since the latter would for zero slope be identical with the log-log centistroke + 0.8 of each liquid. So far such liquids are not known.

The VPH must, therefore, be considered as a purely empirical constant, which presents an improvement over existing indexes only in that it is normally independent of the absolute value of viscosity, and devoid of the arbitrariness of the "viscosity index" system. Of all constants presently in use, it will best serve the purpose desired by Mr. Wilcock, as a group constant for lubricating oils.

Hydraulics oils are manufactured today whose viscosity temperature function is not a straight line on the A.S.T.M. or similar charts, because the state of dispersion of the components changes with temperatures. Their viscosity function will probably never be expressible in simple mathematical formulas. The engineer is in those cases best served by presentation of a curve of the experimental values for the oils he intends to use over the temperature and pressure range he intends to apply them. With many other engineering elements, such as electronic tubes, etc., this has long been a common and safe practice.

In conclusion, we would like to express the hope that this discussion will again bring to general attention the unsatisfactory status of (or really complete lack of) a physically defined scale

[1] "Zur Viskosimetrie," by L. Ubbelohde, Hirzel, Leipsig, 1936.

[2] "Beiträge Zur Viskosimetrie," by A. Bondi, *Petroleum Zeit.*, vol. 34, no. 6, 1938, pp. 1–8.

for the gradation of liquids with respect to their viscosity/temperature and pressure functions. In view of the growing importance of such data for nearly all fields of engineering (lubrication, hydraulic systems, paints, plastics, etc.), a unified effort of all engineering societies and the A.S.TM. toward creation of a scale of temperature coefficients of viscosity in engineering units for all normal liquids and a standardized mode of presentation for colloidal systems seems called for.

A. BONDI.[3]

AUTHOR'S CLOSURE

Mr. Bondi's comments on the writer's proposed viscosity-temperature coefficient serve very well to bring out its advantages, particularly to the hydraulic engineer whose designs and their performance are predicated upon a knowledge of the viscosity-temperature behavior of the hydraulic oil to be used. No exception is taken to the statement that for detailed analyses the engineer is best served by the experimental viscosity-temperature curve. However, the widespread use of "indexes" such as the "viscosity index," A.S.T.M. "slope," and "viscosity pole height" bespeaks the need for a numerical means of comparison.

The fact that within any one group of similar hydrocarbon oils the VTC increases with the 100-deg F viscosity is an apt illustration of its value in revealing true differences in physical behavior, regardless of absolute viscosity. Two oils of such a group, while they may possess the same VPH constant, will exhibit a difference in behavior in hydraulic equipment upon a change in temperature; for example, under laminar-flow conditions and constant-pressure gradient, the increase in rate of flow through a pipe line at 210 F over that at 100 F will be 4.5 fold for Univis 40 (VTC = 0.776) and 5.5 fold for Univis 60 (VTC = 0.818).

Many oils obey the Arrhenius[4] equation

$$\ln \mu = A + \frac{E_{vis}}{RT}$$

where μ is the absolute viscosity, over a wide temperature range. This relation has likewise been derived by Andrade[5] and by Eyring.[6] The VTC is readily shown to be directly related to E_{vis}, the activation energy for viscous flow, by the equation

$$E_{vis} = \frac{RT_1T_2}{T_1 - T_2} \ln \left[\frac{\eta_2 d_2}{\eta_1 d_1}\right] = 3760 \left\{\ln \left[\frac{d_{100}}{d_{210}}\right] - \ln(1 - \text{VTC})\right\} \text{ calories}$$

where d_{100} and d_{210} are the densities at 100 and 210 F, respectively. It has been used in preference to E_{vis} largely because of the ease and rapidity with which it may be calculated.

DONALD F. WILCOCK.[7]

[3] Chemical Engineer, International Lubricant Corporation, New Orleans, La.

[4] "The Viscosity of Pure Liquids," by S. Arrhenius, Meddel. K. Vetenskapsakad Nobelinst., vol. 3, 1916, p. 20.

[5] "A Theory of the Viscosity of Liquids," by E. N. daC. Andrade, *Philosophical Magazine*, vol. 17, 1934, pp. 497–511, 698–732.

[6] "Viscosity, Plasticity, and Diffusion as Examples of Absolute Reaction Rates," by H. Eyring, *Journal of Chemical Physics*, vol. 4, 1936, pp. 283–291.

[7] Research Laboratory, General Electric Company, Schenectady, N. Y.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval and then is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of January 5, 1945, and approved by A.S.M.E. Council on February 5, 1945.

CASE NO. 1010

(Special Ruling)

Inquiry: May the austenitic chrome-nickel steels authorized by Case No. 897 be used in fusion-welded vessels designed for operating temperatures of —20 F and below, when fabricated under the provisions of Par. U-69?

Reply: Owing to their known high-impact strength at low temperatures, it is the opinion of the Committee that the austenitic chrome-nickel steels authorized by Case No. 897 may be used in the fabrication of unfired pressure vessels for low-temperature service under the provisions of Pars. U-69 (with the design stresses given in Table U-2) or U-201 (with 1.25 times the design stresses given in Table U-2) provided:

(1) The material complies with the impact-test requirements of Par. U-142. The impact-test specimens shall be taken from test plates which have been prepared as prescribed in Par. U-68.

(2) All the requirements in Case No. 897 for Par. U-69 vessels, such as heat-treatment, pressure, and thickness limitations, etc., are complied with.

In the construction of vessels for low-temperature service, it is particularly important that extreme care be exercised to avoid stress raisers as might exist if the requirements of such paragraphs as Pars. U-72(**e**) and U-73(**a**) are not fully met.

CASE NO. 1018

(Interpretation of Tables P-5, P-7, U-2)

Inquiry: Tables P-5, P-7, and U-2 cover allowable stresses for fusion-welded pipe made from rimmed steel plate material to Specifications SA-70 and SA-89 Grades A and B. May any other plates for which specifications are covered in the Materials Specifications Section of the Code be used in the fabrication of fusion-welded pipe provided all applicable Code requirements are followed for the service and use for which the pipe is intended?

Reply: It is the opinion of the Committee that plate material conforming to any of the several specifications covered in Pars. P-103 and U-71 may be used in the fabrication of pipe by fusion welding provided:

(1) The welding is performed in accordance with an approved qualification procedure and by approved welding operators in conformance with Code requirements for the particular use for which the pipe is intended.

(2) The allowable design stresses given in Tables P-7 and U-2 for the selected plate material are multiplied by the appropriate joint efficiency from Pars. P-102, U-68, or U-69 dependent upon the type of construction (welding) used in the design of the fabricated pipe.

NOTE: Since Tables P-7 and U-2 under the heading "Tubes and Pipe," subheading "Fusion Welded," lists only stresses for Specifications SA-70 and SA-89 plate material, it will be proper to use the stress given elsewhere in the tables for the plate material selected.

(3) The completed pipe is inspected and stamped as a "Part" where furnished by one manufacturer for another manufacturer. Where such pipe is used as part of power boilers or unfired pressure vessels, the pipe shall be stamped as required by Par. P-332(**f**) except that the "U" symbol shall be applied for the pipe used in Unfired Pressure Vessel Code construc-

tion. Where the welded pipe is fabricated by the manufacturer who completes the vessel, drum, or headers, then no part stamping is required since the Code covers stamping requirements for the completed vessel.

(4) Appropriate manufacturers' data reports are properly executed to cover the inspection of fabrication.

CASE No. 1019

(Interpretation of Pars. P-108, U-76)

Inquiry: It is frequently desirable to stress-relieve a number of vessels having several different plate thicknesses together in the same furnace. Is it permissible to stress-relieve a vessel for a longer time than the test plate which represents it?

Pars. P-102(c) and U-68(c) as now worded do not prohibit this.

Reply: It is the opinion of the Committee that the test plates should be subjected to the stress-relieving operation required by Par. P-108 or U-76 except that if not stress-relieved with the vessel such plates need not be held at the specified temperature for a period of time greater than required on the basis of one hour per inch of thickness of the test plate, but in no case for a materially longer period than the drum itself.

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph number to identify their location in the various sections of the code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

PAR. P-321. Replace second sentence of the second section by the following:

These connections shall be such that they are readily accessible for internal inspection and cleaning. Some acceptable methods of meeting this requirement would be by providing a cross or fitting with a back outlet at each right angle turn to permit inspection and cleaning in both directions, or by using pipe bends or fittings of a type which does not leave an internal shoulder or pocket in the pipe connection and with a radius of curvature which will permit the passage of a rotary cleaner.

PAR. U-60. Add the following as (c):

(c) External piping where connected to a pressure vessel should be installed so as not to overstress the vessel wall.

Revise (b) to read:

(b) Lugs or brackets connected to a vessel used for support or piping connected to it shall be properly fitted to the surfaces to which they are attached. For lugs or brackets attached by riveting the shearing and crushing stresses shall not exceed 40 per cent of the maximum allowable working stresses given in Pars. U-15 and U-16.

TABLE Q-5. Insert reference to Grades A, B, and D of Specification SA-240 in the "P" number 7—"O" number 2 grouping.

SECTION IX OF THE CODE. Insert the following as the third paragraph under General:

Each manufacturer or contractor shall be responsible for the quality of the welding done by his organization and shall conduct tests not only of the welding process to determine its suitability to insure welds which will meet the required tests, but also of the welding operators to determine their ability to properly apply the procedure.

PROPOSED REVISIONS TO INCORPORATE ALTERNATE RULES FOR FUSION-WELDED BOILERS (PARS. P-400 TO P-409) IN BODY OF POWER BOILER CODE

PAR. P-109. Add the following to the first paragraph:

Except where design stresses exceed those given in Table P-7 as permitted under Pars. P-180, P-195, and P-198, the hydrostatic test pressure of such parts need not be more than 1.5 times the maximum allowable working pressure.

PAR. P-113. Add the following to the last paragraph:

Except where design stresses exceed those given in Table P-7 as permitted under Pars. P-180, P-195, and P-198, the hydrostatic test of such parts need not be more than 1.5 times the maximum allowable working pressure.

PAR. P-180(a). Add the following to the definition of *S:*

except for shells or headers of seamless or fusion-welded construction exceeding 1/2 in. in thickness, which shall be built under the provisions of Par. P-180(c).

PAR. P-180(c). Revise to read as follows:

(c) To determine minimum thickness and maximum allowable working pressure for shells or headers of fusion-welded or seamless construction exceeding 1/2 in. thickness, the values of allowable working stress *S* from Table P-7 may be multiplied by 1.25, provided that 0.1 in. is added to the thickness thus determined. Any part requiring staying shall not be designed under this rule. [The factor of safety used in determining the maximum allowable working pressure calculated on the conditions actually obtained in service shall be not less than 5.]

PAR. P-180. Add the following as (d):

(d) Where design stresses exceed those given in Table P-7 as permitted under Pars. P-180(c), P-195(l), P-198(a), or A-125, stresses due to hydrostatic head shall be taken into full account in determining the minimum thickness; also the total of the other stresses due to loads such as the weight of the drums, tubes, water, and distance between drum supports when these stresses increase the calculated stress due to internal pressure over substantial sections of the shell or head by more than 10 per cent. Also all weld reinforcement on both inside and outside of the plates at the longitudinal and circumferential seams shall be removed substantially flush with the surface of the plate.

PAR. P-195(i). Add the following sentence:

The increased working stress allowed by Par. P-195(l) for hemispherical heads and Par. P-195(g) for blank semiellipsoidal heads does not apply to heads with pressure on the convex side.

PAR. P-195(e). Add the following to the last sentence:

and the maximum allowable working stress shall not exceed the values given in Table P-7.

PAR. P-195(g). Add the following to the first sentence:

"as provided in Par. P-180." After "sphere" in the 8th line add "[See (a) and (e)]." Add "as specified in (c)" to the last sentence.

PAR. P-195(m). In the fourth line change "[See (a)]" to "[See (a) and (e)]."

PAR. P-195(l). Add the following to the definition of *S:*

except for heads exceeding 1/2 in. in thickness, to be used only with shells or headers designed under the provisions of Par. P-180(c) and integrally formed on seamless drums or attached by fusion welding and which do not require staying, the values of *S* from Table P-7 may be multiplied by 1.25 for use in the above formula, provided that to the head thickness thus determined, 0.1 in. shall be added. The requirements of Par. P-180 (d) shall also apply.

PAR. P-198(a). Add the following to the definition of *S:*

except for heads exceeding 1/2 in. in thickness, which do not require staying, the values of *S* from Table P-7 may be multiplied by 1.25 for use in the above formula, provided that to the head thickness thus determined, 0.1 in. shall be added. The requirements of Par. P-180(d) shall also apply.

PAR. P-268(a). Add the following as the third paragraph:

In determining the maximum size of an un-

reinforced opening in a shell, head, or header designed under Par. P-180(c), the value of K shall be 1.1 times the value of K computed by the formula for the part of the shell, head, or header that contains the opening. When computing K by the formula, the pressure P shall be that for which the part is designed, S shall be 1.25 times the value from Table P-7, and t shall be the actual full thickness of the shell at the location of the opening, including the 0.10 in. additive thickness. Where K so computed is unity or greater, the maximum size of unreinforced opening shall be 2 in.

PAR. P-268(e). Add the following as the third sentence:

If placed in shells or headers built under Par. P-180(c), openings requiring reinforcement shall have the reinforcement applied equally on the outside and inside of the shell. If not so applied, the amount of reinforcement required shall be calculated for a required shell thickness using design stresses from Table P-7. Openings in heads may have reinforcement on the outside only.

PAR. P-314. Insert the following after the first sentence:

For pressures of 400 lb or over, the feedwater inlet through the drum shall be fitted with shields, sleeves, or other suitable means to reduce the effects of temperature differentials in the shell or head.

PAR. P-320. Insert the following after the first sentence:

For pressures of 400 lb or over, lower water column connections to drums shall be provided with shields, sleeves, or other suitable means to reduce the effect of temperature differentials in the shells or heads.

PARS. A-30 and A-32. Change definition of S to read:

S = safe working stress permitted by Tables P-5, P-6, or P-7 for the material at the maximum operating temperature as determined by Code requirements.

PARS. A-67, A-69, A-70. Add the following sentence in each of these paragraphs at the conclusion of the example:

This example is for a shell built to stresses permitted by Fig. P-7. For fusion-welded or seamless construction where design stresses exceed those given in Table P-7 as permitted under Pars. P-180(c), P-195(1), and P-198(a), this example will have a different value of S and K but the procedure of calculation will be similar.

PAR. A-125. Revise the definition of S to read:

S = maximum allowable working unit stress, pounds per square inch, taken from Table P-7. The values from Table P-7 may be multiplied by 1.25 provided that 0.10 in. is added to the thickness thus determined and the requirements of Par. P-180(d) are complied with.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Diamond Tools

DIAMOND TOOLS. By Paul Grodzinski. Anton Smit & Co., Inc., New York, N. Y., 1944. Cloth, 5½ × 8 in., 379 pp., illus., $4.50.

REVIEWED BY CARL L. BAUSCH[1]

LITERATURE of this type, giving a short but rather complete survey on the results obtained in the use of diamond tools in industry, is scarce. The author describes the production and quality of diamonds in general and the selection for different industrial applications. Mention is made of other precious stones where they are used in a similar way to diamonds. The application of diamonds in most fields is covered; for example, for wear-resistant bearings, hardness testing, truing of abrasive wheels, as metal and nonmetallic cutting tools, for machining of glass and stone, for rock drilling, for engraving tools and fine wire drawing tools, and for use as an abrasive material.

Although the practices described are largely European, they seem to conform quite closely to American practice.

An index would improve the book for the hurried reader.

[1] Vice-President, Bausch & Lomb Optical Co., Rochester, N. Y. Fellow, A.S.M.E.

Normal Lives for the Disabled

NORMAL LIVES FOR THE DISABLED. By Edna Yost, in collaboration with Lillian M. Gilbreth. The Macmillan Company, New York, N. Y., 1944. Cloth, 6 × 8 in., 198 pp., $2.50.

REVIEWED BY ALLAN R. CULLIMORE[2]

IN the words of the authors, "The one great aim of this book is to help a disabled man (civilian or service man) avoid being numbered among those who receive less than their fair due if more is needed to make him economically independent—assuming his co-operation in every way with those whose job it is to help him become self-supporting. For the chances are that he can get what is needed if he goes about it in the right way."

The book clearly, directly, and adequately sets forth the services and the material benefits that are available for the disabled and outlines in detail the procedures to be followed in profiting by these services. Concerning help which is rendered to a man by himself, a philosophy is tacitly assumed and lightly touched upon, a philosophy which the reviewer wishes might have been expanded and elaborated further. Perhaps it might be stated in some language as this:

No matter what the disabling circumstances may be, the man that is left is left with the normal desires, urges, yearnings, joys, and sorrows which we will all feel as human beings. He may have to make few adjustments or many, but, after all, the making of adjustments is, again, a normal procedure, and the making of them by the man himself assures normality.

As the authors point out (if the reviewer reads aright), the mutilation of the Venus de Milo does not destroy her beauty, and the visible disability involving the loss of both arms is swallowed up in her basic normality. Perhaps these disabled can be helped most—and the reviewer believes they can—by stressing those common things which all of us, hurt and unhurt alike, share together rather than by exaggerating those accidental hurts and emphasizing the superficial disability at the expense of the basic normality.

All about us, in all ways of life, we see adjustments being made naturally and continually; little abnormalities and big ones merging into the normal, so that a man with one adjustment or many to make is not a thing apart but just one of us human beings with another hurt to adjust. Perhaps, after all, these physical disabilities are easier for us, and the public, to understand than some of the invisible ones which some of us succeed in covering up so completely that we are judged as normal. If we think of it, some things which are really disabilities have come to be almost normal. Some of

[2] President, Newark College of Engineering, Newark, N. J. Mem. A.S.M.E.

us, considered to be pretty well balanced and having no particular abnormalities to adjust, still have to adjust ourselves to bifocals, and some to dentures, and some to the loss of a finger, but, after all, these fundamentally are the same procedure.

The reviewer finally feels called upon to remark on what he considers to be the brightest side of the picture. Our machine age has given us an opportunity to make adjustments, particularly occupational, which have hitherto been impossible. Machines were made to improve on the production of *just* hands, eyes, and feet. The whole philosophy of a machine age has to do, fundamentally, with the minimizing of the importance of purely manual (hand or foot) labor. With these machines occupational limitations disappear often completely in the face of a machine that works faster and better than human hands, or one that runs faster and longer than human feet. We have now machines to see stars that we cannot see with normal eyes and machine ears to hear sounds that our normal ears do not bring us unaided. This is, at least, one field in which engineers and machines have and will directly brighten the hopes of many and make their adjustments actually much easier.

Books Received in Library

ALLOY CAST IRONS. Second edition. Reviewed, revised, and published by the Alloy Cast Irons Committee, Gray Iron Division, American Foundrymen's Association, Chicago, Ill., 1944. Cloth, 6 × 9¼ in., 282 pp., illus., diagrams, charts, tables, $3.25. The effects of alloys on cast iron, the alloys available for foundry use, the effect on physical properties, methods of adding them, the heat-treatment of alloy cast irons, foundry practice, and specific uses are discussed in this volume. The various chapters have useful bibliographies.

ANYTHING A HORSE CAN DO, THE STORY OF THE HELICOPTER. By H. F. Gregory, introduction by I. Sikorsky. Reynal & Hitchcock, New York, N. Y., 1944. Cloth, 5½ × 8¼ in., 243 pp., illus., diagrams, $3. In an easy, informal way this book tells the story of helicopter development. The author traces its history, explains its principles and discusses its future. As an expert for the U. S. Army, the author has played a large part in the development of this plane and much of his story is the record of personal experience.

BROACHES AND BROACHING. First edition, Broaching Tool Institute, New York, N. Y., 1944. Fabrikoid, 8 × 11 in., 97 pp., illus., tables, $3. A brief historical sketch precedes a discussion of the advantages, applications, and limitations of broaching. The later chapters give technical information on the types of broaches, design procedure, and current broaching practice. The subject of costs is briefly treated.

DIVING, CUTTING, AND WELDING IN UNDERWATER SALVAGE OPERATIONS. By F. E. Thompson, Jr. Cornell Maritime Press, New York, N. Y., 1944. Cloth, 5 × 7½ in., 214 pp., illus., diagrams, tables, $2. This book is intended both as a text for men who are learning the work and as a practical manual for all those who are actively engaged in such operations. The material covers diving theory and practice under varying conditions, describes and demonstrates the use of all types of cutting and welding equipment for underwater work, and includes a section of useful data and definitions.

EXPERIMENTAL STRESS ANALYSIS, Proceedings of the Society for Experimental Stress Analysis, vol. 2, number 1, held at the Hotel Statler, Boston, Mass., May 18–20, 1944; published and distributed by Addison-Wesley Press, Cambridge, Mass. Cloth, 8½ × 11¼ in., 225 pp., illus., diagrams, charts, tables, $5. This volume contains the papers presented at the 1944 spring meeting of the Society and symposium on residual stresses. Twenty-one papers are included, which discuss methods of measuring residual stresses and related topics.

(THE) INDUSTRIAL SUPERVISOR, A Training Guide for Improvement of Skill and Leadership. By J. M. Amiss and T. C. Sutton. Ronald Press Co., New York, N. Y., 1944. Cloth, 5¼ × 8¼ in., 243 pp., diagrams, tables, $3. The beginning chapters discuss general supervisory responsibilities and the general qualifications of a supervisor. Succeeding chapters deal with the many specific responsibilities of the supervisor from a practical viewpoint, provide necessary technical information, and show how particular qualifications may be gained or improved. The book is intended for home study, industrial training departments, or conference discussions by small groups.

HENLEY'S TWENTIETH CENTURY BOOK OF FORMULAS, PROCESSES, AND TRADE SECRETS, edited by G. D. Hiscox, 1944; revised and enlarged edition by T. O. Sloane. Norman W. Henley Publishing Co., New York, N. Y., 1944. Cloth, 5½ × 8½ in., 865 pp., diagrams, tables, $4. This well-known collection of recipes, formulas, and processes has again been revised. New formulas have been added and new sections included on plastics and on photography. Old formulas have been replaced by better ones.

MECHANICAL INSTALLATIONS. (Postwar Building Studies No. 9.) Compiled by the Institution of Mechanical Engineers and published by His Majesty's Stationery Office, London, England, 1944. Paper, 6 × 9½ in., 119 pp., diagrams, tables, 2s. (Obtainable from British Library of Information, New York, N. Y., $0.60.) The object of this series of British reports is to secure a comprehensive and co-ordinated review of building technique for the guidance of those who will be responsible for the direction and organization of building after the war. This present report on mechanical installations covers the following: lifts, hoists, and escalators; cooking installations (except for homes); heating, ventilating and air conditioning; wells, bore-holes, and fire-fighting appliances; building power plants; and refrigerator equipment in buildings.

METALLOGRAPHY AND HEAT-TREATMENT OF STEEL. Ferrous Metallurgy, vol. 3. (Mineral Industries Series.) By E. J. Teichert. Second edition. McGraw-Hill Book Co., Inc., New York and London, England, 1944. Cloth, 5¼ × 8½ in., 577 pp., illus., diagrams, charts, tables, $5. The text on ferrous metallurgy, of which this is the final volume, is intended especially for those employed in the steel industry who wish to acquire a working knowledge of fundamental principles. In this volume the physical metallurgy of the iron and steel alloys, metallography, and heat-treatment are considered. The work is well adapted for private study.

Mitteilungen aus der Versuchsanstalt für Wasserbau an der Eidgen. Techn. Hochschule in Zürich. No. 5 EXPERIMENTELLE UND THEORETISCHE UNTERSUCHUNGEN ÜBER DAS KOLKPROBLEM, by W. Eggenberger and R. Müller. 6 × 8¾ in., 78 pp., 9.80 Sw. fr.

No. 6 DE LA STABILITÉ DES CHAMBRES D'ÉQUILIBRE ET DES SYSTÈMES DE CHAMBRES D'ÉQUILIBRE, by C. Jaeger. 9 × 12½ in., 12 pp., 2 Sw. fr.

No. 7 ERDBAUMECHANISCHE PROBLEME IM LICHTE DER SCHNEEFORSCHUNG, by R. Haefeli. 9 × 12½ in., 14 pp., 3 Sw. fr.

Verlag A.G. Gebr. Leemann & Co., Stockerstr. 64, Zürich, Switzerland, 1944. Illus., diagrams, charts, tables, paper. These three contributions of the Swiss hydraulic experiment Station deal respectively with the following topics: No. 5. Experimental and theoretical investigations of eddy formation by overflow, underflow, or combination. No. 6. Discussion of the stability of surge tanks and systems of surge tanks in the regulation of hydraulic turbines. No. 7. Soil mechanics of problems in the light of research on snow.

PLASTIC MOLDING AND PLANT MANAGEMENT. By D. A. Dearle. Chemical Publishing Co., Brooklyn, N. Y., 1944. Fabrikoid, 5½ × 8¾ in., 196 pp., illus., charts, tables, $3. Although books on plastics are numerous, not much has appeared on the actual problems that arise day by day in the molding plant. The present work is intended to assist the plant operator. The construction and maintenance of molds, methods of compression and injection molding, production problems, cost control, and plant management are discussed in a practical way.

PLASTICS IN THE WORLD OF TOMORROW. By B. W. Leyson. E. P. Dutton & Co., New York, N. Y., 1944. Cloth, 5½ × 8¼ in., 184 pp., illus., $2.50. A general survey of the subject, intended for nontechnical readers, is provided in this book. The various plastics are described, their uses enumerated and future possibilities discussed.

PRINCIPLES OF PHYSICS, vol. 1, Mechanics-Heat, and Sound. By F. W. Sears. Addison, Wesley Press, Cambridge, Mass., 1944. Cloth, 6 × 9¼ in., 526 pp., illus., diagrams, charts, tables, $5. This text is based on the first course in physics given at the Massachusetts Institute of Technology. It covers the subjects, mechanics, heat, and sound, which form the first year of the two-year course, and is given to students who are concurrently given a course in analytical geometry and calculus. Throughout the emphasis is on physical principles, and the calculus is used freely. Numerous problems are provided.

SIMPLIFIED TIME STUDY. By H. J. Myers. Ronald Press Co., New York, N. Y., 1944. Cloth, 5½ × 8½ in., 140 pp., illus., diagrams, charts, tables, $2.50. Intended especially for shop foremen, cost men, and others who can use time studies to advantage, but to whom the results of elaborate, detailed studies are not available. Simple methods are described and basic principles are presented, with as few technicalities as possible.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by A.S.M.E. members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Harrison W. Craver, Director, Engineering Societies Library, 29 West 39th St., New York, N. Y.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

R. E. Gillmor Addresses War Production Conference

Nine Panel Discussions Follow Dinner Program

THIRTEEN hundred people attended the first conference on War Production and Future Planning presented by the Engineering Societies Committee on War Production, at the Hotel Commodore, New York, N. Y., Jan. 30, 1945.

The Engineering Societies Committee on War Production was created to co-ordinate the services of the many engineering and technical societies for the purpose of offering to businessmen, manufacturers, and engineers technical and other information that would help solve problems encountered in production. An annual conference with panels headed by outstanding engineering and technical experts for the purpose of large-scale consultation with manufacturers and their representatives was the medium chosen to describe and help solve production problems.

Sponsors

Its sponsors are: The American Institute of Chemical Engineers; American Institute of Electrical Engineers; American Institute of Mining and Metallurgical Engineers; the Institute of Radio Engineers; the American Society of Civil Engineers; The American Society of Mechanical Engineers; the American Society of Safety Engineers; the American Society of Tool Engineers; American Foundrymen's Association; American Society for Metals; American Society for Testing Materials; American Welding Society; Society for the Advancement of Management; Society of Automotive Engineers; Society of Naval Architects and Marine Engineers; Committee for Economic Development; National Association of Manufacturers.

Committee members are: Chairman, Harold C. R. Carlson, A.S.M.E., Lee Spring Company, Inc., Brooklyn, N. Y.; Vice-Chairman, Howard P. Wall, A.S.S.E., American Optical Company, 70 West 40th St., New York, N. Y.; secretary, Myron P. Davis, A.S.T.M., Otis Elevator Company, Yonkers, N. Y.; treasurer, Roland W. Flynn, A.S.M.E., Gulf Oil Corporation, New York, N. Y.; W.P.B. liaison member, C. W. McGriff, assistant deputy regional director; C.E.D. liaison member, A. B. Zook; N.A.M. liaison member, R. W. Sparks; Program Committee chairman, J. S. Vanick, A.F.A., International Nickel Co., New York, N. Y.; Dinner Committee chairman, H. R. Kessler, A.S.M.E., Republic Flow Meters Co., New York, N. Y.; Arrangements Committee chairman, R. W. Sparks, N.A.M.; Publicity Committee chairman, P. F. Stricker, A.S.S.E.; Promotion Committee chairman, C. A. Hescheles, A.S.M.E.

Panel Discussions

The conference opened with a dinner in the grand ballroom of the Hotel Commodore. Toastmaster Sidney D. Kirkpatrick, editor, *Chemical & Metallurgical Engineering*, introduced the speaker of the evening, Reginald E. Gillmor, president, Sperry Gyroscope Co., Inc., whose subject was "The Creative Mind and Victory." After the dinner program the audience dispersed to the smaller ballrooms to take part in the panel discussions in which they were most interested. Nine panel discussions featured the after-dinner program; among them were the subjects of "Safety Engineering," "Metals Industries," "Postwar Construction," "Management and Manpower," and "Utilization of Metals and Alloys in Industry With Particular Reference to Transportation."

The creation of the Engineering Societies Committee on War Production and its conference on War Production and future planning was accomplished with the co-operation of the War Production Board.

Actions of A.S.M.E. Executive Committee

At a Meeting Held at Headquarters, Jan. 26, 1945

THE Executive Committee of the Council of The American Society of Mechanical Engineers met at the Society headquarters, New York, N. Y., on Jan. 26, 1945. There were present: Alex D. Bailey, President of the Society, who presided; A. C. Chick, R. F. Gagg, and D. W. R. Morgan, of the Committee; J. J. Swan (Finance), J. H. Sengstaken (Professional Divisions), A. R. Mumford (Sections), K. W. Jappe, treasurer, R. M. Gates, junior past-president, W. H. Larkin, chairman, Nominating Committee, Alfred Iddles, chairman, and E. B. Ricketts, member, of the Special Committee on Power Test Codes, C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

The following actions were of general interest:

Appointments

Approval was voted of the appointment of R. F. Gagg as vice-chairman of the Executive Committee of the Council.

Confirmation was voted of the appointments of the chairmen and secretaries of the several professional divisions.

Contract With Chief of Ordnance

Approval was voted of a contract between the Society and the Chief of Ordnance (Army) for the conduct of research on finishing and machining of steel shells.

Subcommittee on Miniature Boilers

Reorganization of the Subcommittee on Miniature Boilers of the Boiler Code Committee was approved with the following personnel: J. W. Turner, chairman, William Ferguson, W. H. Furman, E. W. Mears, and J. G. Wheatley.

Development Fund

Donald S. Walker, chairman of the Development Fund Committee, reported the receipt of $39,894 from 74 contributors as of Jan. 26, 1945. Approval of a statement of the purpose of the fund and rules of administration was voted. K. W. Jappe, Treasurer of the Society, was appointed Fund Officer of the Development Fund. (See page 209.)

Properties of Gases

The Executive Committee voted that, subject to review and approval of the Standing Committee on Research, the Society establish a Special Research Committee on Gas Properties and that the Research Committee be directed to co-ordinate this with the plans under way by the Gas Properties Committee of the Heat Transfer Division.

Lectureships

It was reported that the Committee on Lectureships had planned the following program for 1945:

1 Dr. Lionel S. Marks to lecture in 1945, preferably to Group VII area.

2 Dr. Stephen Timoshenko to lecture in 1945 in Group I area.

3 Dr. W. Trinks to lecture, preferably in the heavy-industry area which combines parts of Group V and Group VI.

4 Dr. Lillian M. Gilbreth to give two series of lectures during October and November, and in April, covering the Mississippi Valley Sections and Group III.

Postponement of Meetings

In view of the request of the Government that meetings be postponed to relieve hotel and railroad congestion, the Committee voted:

1 To postpone the Spring Meeting in Boston, April 16–18, 1945, and the Semi-Annual Meeting in Chicago, June 17–21, 1945.

2 To request the Secretary to develop a means, within the constitution, for having a Business Meeting of the Society in June at a place to be selected.

3 To encourage the technical committees to hold their necessary meetings.

4 To request the Committee on Meetings and Program, in conjunction with the Committees on Sections and Professional Divisions, to develop at an early date means for advancing the technical work of the Society in place of the meetings which have been postponed.

5 To request the Oil and Gas Power and Applied Mechanics Divisions to present their recommendations as to the meeting each has planned to be held in May.

Society Organization

Procedures were discussed for making effective the recommendations in the report of the Committee on Society Organization Structure.

Chinese Institute of Engineers

Howard Coonley, member A.S.M.E. and president of the Walworth Company, New York, N. Y., now in China as one of Donald M. Nelson's American experts "to set up a Chinese WPB," was designated an honorary vice-president of the Society as its special representative to the Chinese Institute of Engineers, of Chungking, China.

Postwar Germany

Past-President R. M. Gates reported on the progress of the Joint Conference Committee regarding participation in problems relating to postwar Germany.

James Watt Medal

It was reported that the 1945 James Watt International Medal had been awarded by The Institution of Mechanical Engineers to Dr. F. W. Lanchester, of Birmingham, England.

United Engineering Trustees, Inc.

The following statement of policy for the guidance of A.S.M.E. representatives of the United Engineering Trustees, Inc., was adopted:

"The Executive Committee of the Council has reviewed the needs of the engineering profession for a suitable building to house its Library and office facilities. The Committee expresses concern that the present building is not sufficiently large or modern to house adequately the several engineering societies. The Society itself has cramped headquarters and is considering renting a large space outside of the building.

"The Executive Committee of the Council therefore urges its Trustees to give unstinted support to increased emphasis on the program under way by the U.E.T. to provide a suitable engineering building. The Committee suggests that plans made include the Engineers' Club and the smaller engineering societies not now housed in the building. The Committee further pledges its aid and support to the Trustee representatives to bring about the desired result."

A.S.M.E. National Meetings Postponed

THE Executive Committee of the Council of The American Society of Mechanical Engineers at its meeting on Jan. 26, 1945, decided to postpone indefinitely the Spring and Semi-Annual Meetings which were scheduled to be held in Boston and Chicago, respectively. This action was taken in order to co-operate with the spirit of the ban on all meetings and conventions issued by the government on account of the railroad transportation emergency. Unfortunately, when this action was taken, printing of the February issue had been completed, and it was therefore not possible to change the announcement of the Spring Meeting in Boston which had been prepared before the ban went into effect.

The Executive Committee of the Council expressed the hope that the various program-making agencies of the Society would continue to develop technical papers.

Papers which would have been used either at Chicago or at Boston will be made available to local sections for presentation at special local meetings to take the place of the postponed national meetings. Certain papers may be published by the Society even though they are not presented at a meeting for discussion.

The Secretary's office will be glad to receive suggestions of papers which members are willing to offer to the Society under emergency conditions and suggestions of subjects which will aid in the production of war matériel.

The Boston Section has decided to hold a one-day meeting of its own members to discuss some of the papers which had been scheduled for the Spring Meeting.

The Executive Committee of the Council has deferred decision on holding the Fall Meeting, now scheduled for Cincinnati, October 1–3, and the Annual Meeting, now scheduled for New York during the week of November 25.

Dr. Lanchester Receives 1945 James Watt Medal

THE council of The Institution of Mechanical Engineers has awarded the 1945 James Watt International Medal to Dr. F. W. Lanchester, of Birmingham, England.

Dr. Lanchester's work in aerodynamics is recognized throughout the world. The Lanchester-Prandtl theory is basic to all modern developments in the field of aerodynamics. Apart from this, his work on prime movers had been recognized as of fundamental importance. Besides his scientific work of outstanding distinction, Dr. Lanchester is also recognized as a practical engineer whose work will have a permanent place in the history of technology.

The medal was founded by the Institution in 1936 to commemorate the bicentenary of the birth of James Watt on January 19, 1736—an event which was destined to bring about a revolution in the utilization of power. The medal is awarded every two years to an engineer of any nationality who is deemed worthy of the highest award that the Institution can bestow and that a mechanical engineer can receive. In making the award the Institution has secured the co-operation of the leading mechanical-engineering institutions and societies in all parts of the world.

To be worthy to receive a medal struck in commemoration of one who was at one and the same time a scientist, an inventor, and a producer, the recipient himself should be an engineer who has achieved international recognition both by his work as a mechanical engineer and by the ability with which he has applied science to the progress of mechanical engineering. The Institution recognizes, however, that only rarely will it be possible to find men in whom these qualities are so equally balanced as in James Watt. It therefore considers men who have attained world-wide eminence in mechanical engineering in any direction—science or research, invention or production. Hence a great inventor, though he be not a scientist, or a great thinker and teacher, though he be not a designer or inventor, or a great organizer of methods of production in engineering works, is eligible for the medal.

Navy Department Submits 25 Inventive Problems

FROM time to time in this section lists of problems on which The Inventors Council is seeking solutions have been published as an aid to the war effort.

The appended list of 25 inventive problems for which the Navy Department is seeking solutions has been forwarded by The Inventors Council. Suggested solutions should be prepared in sketch and description form and sent to The National Inventors Council, Department of Commerce, Washington, D. C., for consideration and report.

1 *A satisfactory shockproof aerial delivery container* not requiring a parachute; possibly pneumatic-cushioned, the cushions to be inflated from a CO_2 bottle after leaving the plane. Inexpensive enough to warrant its being classed as expendable after being used once.

2 *A beach marker light*, to be visible from 5000 yards out to sea with rechargeable or nondeteriorating battery. Not in excess of 5 lb weight. Effective burning time: 70 hours continuous use, or 7 days of 12 hours on, 12 hours off use.

3 *Device for transmitting rotary motion through a moistureproof barrier.*

Applications: Shafts for control knobs on radio equipment provided with immersion-proof case; generator shaft for field telephones equipped with immersion-proof cases; generator shafts for hand-cranked power supplies for field radio equipment.

Characteristics: Should prevent entrance of water or moisture vapor when immersed to a depth of ten feet; should offer a minimum of frictional opposition to rotary motion; should be small in relation to the equipments to which applied; should have ample power-transmission capability; should be applicable to existing equipment with a minimum of modification.

4 *Waterproof jack:*

Applications: Microphone, headphone, and key jacks for telephone equipment.

Characteristics: Should prevent water or moisture vapor from penetrating equipment, even when immersed to a depth of ten feet; should be capable of cleaning and drying without tools; should accommodate standard plugs.

5 *A durable plastic-impregnated fabric*, waterproof, weighing less than 6 ounces per square foot. Suitable for tentage.

6 *A gasoline-resistant coating* for the interior

of gasoline drums and not adversely affected by gasoline.

7 *An oil or liquid knapsack sprayer* for use especially in malaria-control work in overseas theaters, which (*a*) is of simple construction, (*b*) has easily replaceable and reproducible parts, (*c*) has a minimum of rubber parts and gaskets, and (*d*) is light, rugged, durable, and leakproof.

8 *Proofing material* which will make tentage and tarpaulin more resistant to the rapid rotting that now occurs in humid tropical climates.

9 *Directional drum lens:* The Coast Guard uses a large quantity of 200 mm, fresnel-type drum lenses on lighted aids to navigation. These lenses provide a 360-deg fan beam of uniform candlepower about the horizon. In many instances the candlepower in a specific direction should be considerably higher than that of the uniform beam. Present practice in such cases is to install an auxiliary "spot" light to increase the intensity in the specific direction.

A need exists for a single lens which will permit the function of both of the above lights to be accomplished from a single light source. The lens should have the over-all dimensions of the present 200-mm drum lens to permit its being used in the existing housings.

10 *Single unit range light:* A single optical device which will indicate with a reasonable degree of sensitivity a vessel's lateral deviation from the center line as it proceeds along a narrow channel. Such a device must be inexpensive and low in power consumption. The conventional aid to navigation for such purposes consists of two lights on the prolongation of the center line separated some distance from each other with the rear light higher than the front. It is in the interests of economy, and also to provide against the fact that the terrain may make the installation of two lights impractical, that this device is needed. Economy involves current consumption and cost of structures. Existing 2-light ranges require approximately 50 kwhr per year for a candlepower of 10,000 white.

11 *A portable fire extinguisher* using liquid similar to the carbon-tetrachloride (or Pyrene) type, suitable for use around electrical equipment which will not form phosgene or other toxic gas when used to extinguish fires, as is the case with the carbon-tetrachloride extinguishers.

12 *A continuous sampling combustible gas indicator* with automatic alarm which is simple, positive, inexpensive, and suitable for installation in gasoline-driven motorboats for continuous sampling of the vapor in the bilges.

13 *A polyphase a-c integral hp motor* up to 50 hp, whose inrush current does not exceed the running current and whose starting torque equals the running torque.

14 *A small portable field-strength meter* about the size and weight of a walkie-talkie for rapid checking of radio field intensities in the vicinity of radio transmitting stations. The instrument must be simple to use and accurate within plus or minus 10 per cent. Frequency range desired is to 100 kc to 20,000 kc. The range of field intensities desired is from 10 to 1000 millivolts per meter.

15 *Radio antennas* up to 300 ft in height that can be set up by unskilled ground crews. The efficiency of radio devices is often limited by the extreme difficulty of obtaining reasonable antenna heights quickly in the field. Very light alloys and special rigs for rapid erection by a ground crew without climbing are desired, in addition to ability to dismantle or collapse into packages not exceeding 20 ft in length. Insulated-base vertical antennas are preferable but grounded-base type could be used if the device had enough other advantages in the way of ease of erection and ruggedness.

16 *A cheap and effective barrier* to prevent the propagation of cracks in steel structures, without making use of riveted seams and the calking, etc., incidental thereto.

17 *A method of welding high-pressure piping* without the aid of backing straps or with back straps which would be soluble in a harmless solution which could be introduced in the pipe before putting same into service.

18 *A method of measuring the elastic stresses* locked up in steel or other metallic structures at and beneath the surface of the material without having to dissect the structure in order to record the elastic recovery which results from isolating various segments.

19 *A method of welding light-gage aluminum.* This is of particular interest since aluminum lifeboats and life rafts are currently of riveted construction due to the lack of a satisfactory method of welding.

20 *A "nonslipping" shoe sole* which will give good footing on an oily steel deck of a ship rolling as much as 17 deg. This shoe sole should be noninjurious to feet, nonsparking, and reasonably long-wearing.

21 *Small aircraft-type direct-current motors* without commutators, slip rings, or any other moving contact arrangements, so as to eliminate service difficulties with commutators and electrical noise produced thereby.

22 *A precision twin-triode vacuum tube* with general characteristics of the current 6SN7 type having the following additional precision features:

(1) After a fifteen-minute warm-up, the gm of the two sides shall be equal over the normal operating range to within + 1 per cent.

(2) The tube shall be completely nonmicrophonic.

(3) The above characteristics to be maintained over an ambient temperature range + 80 C to —40 C.

(4) It would be possible to produce this tube by mass-production methods with not more than 10 per cent rejects.

(NOTE: Tubes presently available in production permit excessive variation in grid-plate conductance in the separate halves of the tube.)

23 *A small Hooke's joint or Universal joint for instrument use*, the efficiency of which is sensibly constant with angularity of output shaft axis up to 10 deg. For above shaft axis angularity units, the Hooke's joint should have an angular velocity ratio of input to output shafts constant and equal to unity over the cycle with as high an efficiency as possible.

24 *An expendable, compact, lightweight, rugged, mechanical device* to permit successive closures of up to eight electrical circuits with a time interval between closures of about 0.2 to 0.3 seconds.

25 *A small, fast-acting, double-action solenoid* to operate on 28 volts direct current, with a stroke of about 0.5, with a 20 lb pull (or push) at condition of maximum air gap. The plunger should "seat" at each end of travel and would very probably have to be an electromagnet whose polarity would reverse at each end of travel.

A. H. Compton Receives Washington Award

THE Washington Award Commission has elected Dr. Arthur Holley Compton, dean, Division of Physical Sciences, and chairman, Department of Physics, University of Chicago, as recipient of the Washington Award for 1945.

The Award was presented at a dinner held in the Stevens Hotel, Feb. 21, 1945. The A.S.M.E. was represented at the dinner by F. H. Lane, who is chairman of the Chicago Section.

I.R.E. Inaugurates Building Fund Campaign

AT its winter technical meeting in New York, N. Y., January 24–27, the Institute of Radio Engineers inaugurated a campaign for the raising of $500,000 for a building fund, in anticipation of postwar expansion of its service to the electronic and communication industries. The directors of the society announced that they are leaving their plans flexible enough to permit their establishing new quarters jointly with other engineering and scientific societies if to do so ultimately proves desirable. The appeal for funds will extend to the Institute's membership and interested corporations.

Colvin to Head I.A.S.

CHARLES H. COLVIN, member A.S.M.E., has been elected president of the Institute of the Aeronautical Sciences for 1945. He succeeds Major R. H. Fleet of San Diego, Calif.

Elected as vice-presidents were: W. A. M. Burden, Assistant Secretary of Commerce; Leroy R. Grumman, president of Grumman Aircraft Engineering Corporation, Bethpage, Long Island; I. M. Laddon, executive vice-president of Consolidated Vultee Aircraft Corporation, San Diego, Calif., and Arthur E. Raymond, vice-president in charge of Engineering of Douglas Aircraft Company, Santa Monica, Calif. Earl D. Osborn, president of Edo Aircraft Corporation, Flushing, Long Island, was elected treasurer.

Major Lester D. Gardner was re-elected chairman of the council; Bennett H. Horchler, executive vice-president; George R. Forman, assistant to the president; Robert R. Dexter, secretary, and Joseph J. Maitan, controller.

Tucker to Edit Refrigeration Abstracts

J. MACK TUCKER, associate professor of mechanical engineering, University of Tenn., and a member of the A.S.M.E., has been appointed editor of "Refrigeration Abstracts," new A.S.R.E. publication. This announcement was made at the 40th annual meeting of the A.S.R.E. in New York, N. Y., by A. B. Stickney, retiring president.

President's Page

The Development Fund

INSURANCE FOR THE FUTURE

ONE of the most useful though perhaps less widely known activities of the Society is its work in developing codes, standards, standard practices, research reports, and special publications. This work, which is done under the direction of the Boiler Code Committee, Power Test Codes Committee, Research Committee, Safety Committee, Standards Committee, and other special groups, represents a tremendous amount of time and effort, not only on the part of the committee and subcommittee members, but on the part of the Society's staff who painstakingly work out the details and place in written form accepted practices for boiler construction, testing of power equipment, and the results of extensive research programs. The catalog of these publications is large and impressive. In total, they represent an important contribution to the development of the best basic techniques and knowledge which are the essential tools of an engineer's daily life and which have become the accepted standards of industry.

In addition to the codes, standards, and reports, the Society is called upon to issue many special publications of value to the members and to industry. In the past these publications have included biographies of eminent engineers, bibliographies on a great variety of important subjects, reprints of foreign documents, and reports of foreign engineering societies, as well as translations and publications of important foreign research reports and books. While the direct expense for the publishing of some of these documents has usually been covered by the sale, the cost of the staff to support the committees and any deficits incurred have been borne by the Society. This support has been provided by the Council as evidence of the Society's recognition of its responsibility to maintain and improve the best engineering practice.

Because of the increasing demands on the Society for this service and the increasing cost of it, which so far has been supported by membership, and in anticipation of greater demands in the future, it was felt that the various industries that depend on mechanical engineering for their successful operation should provide a Fund which would insure the carrying on of these activities which are so important to them. This Fund will be kept separate from all other funds or activities of the Society and disbursements will be made by the Fund officer only by authorization of the Council. Net revenue from the Fund will redound to the Fund. An annual statement of the Fund will be prepared each year and embodied in the annual statement of the Society.

This Fund, which will be called the Development Fund to distinguish it from other reserves, will not be used to support current researches or other activities which are customarily maintained by the industries or individuals who benefit directly from the particular activity. It will help to support the work of the staff previously referred to and to initiate special projects of various types which arise from time to time and are not easily classified. It is important that the membership know about this Fund and its purpose.

The Development Fund was instituted in December, 1944, and substantial contributions have already been received. We take this opportunity to express our appreciation to those who are making it possible to carry on this important work of the Society.

(*Signed*) ALEX D. BAILEY, *President*, A.S.M.E.

N.A.C.A. Presents Research Policy

J. C. HUNSAKER, chairman of the National Advisory Committee for Aeronautics presented on Jan. 26, 1945, to the House Select Committee on Postwar Military Policy a statement entitled "Aeronautical Research Policy." A brief summary of this statement follows:

Opportunities for Research

Since the establishment of the National Advisory Committee for Aeronautics by the Congress in 1915, experience has shown that the value of the airplane for national defense and for commerce has directly followed the evolution of an advancing technology based on research. By a combination of initiative and technical competence in research, Army and Navy and manufacturing industries have created superior airplanes of both military and civil types to meet ever-increasing performance requirements. Accelerated enemy research and development created an opportunity for aggression which was promptly exploited. This lesson must not be forgotten. During the war the N.A.C.A. has expanded its research facilities and the Army and Navy have increased their facilities for experiment and evaluation. Results already obtained make it apparent that there are further opportunities for substantial improvement in the performance of aircraft and equipment which can be realized only by a vigorous research program.

Necessity for Research

It is necessary to continue research to assure American leadership in military aviation development. The Committee believes it to be in the public interest to foster a greatly increased civil use of the airplane for domestic and international air lines and for private operation. To realize improvements in safety, performance, reliability, utility, and economy, research must solve some difficult problems. Further research is necessary to find practical applications for new designs of civil airplanes. The N.A.C.A. should endeavor to direct an increasing proportion of its research effort to the technical problems of civil aviation with a view to their practical solution.

In time of peace the application of research results to military and naval objectives is extremely important. Exploration of military applications by continuous experiment and testing by professional soldiers and sailors is necessary, as is the evaluation of the products of industry by the military users. Effective use must be made of all existing facilities for research, development, and evaluation; they must be kept modernized; and the results of research conducted at public expense should be made available to manufacturers and operators so as to stimulate the growth of healthy competition in the supply of goods and services.

Policy

The principal objective of the N.A.C.A. is fundamental research in the aeronautical sciences. Research is not considered completed until results are tested by sufficient practical application. Research programs are formulated in close collaboration with technical personnel from the government agencies concerned and from industry, through membership on appropriate subcommittees. Research acilities may be used to assist a government agency in evaluation of specific aircraft and equipment, whenever facilities available to that agency are inadequate; they may be used to assist private individuals and corporations whenever commercial facilities are not available, so long as the investigation is considered by the N.A.C.A. to be in the public interest and the cost is met by the individual or corporation requesting assistance. Recognizing that competition for quality should be stimulated and competitive engineering organizations encouraged, application of research results to the design of improved aircraft and equipment both civil and military is the function of the industry. Evaluation of military aircraft and equipment developed by the industry and the exploration of possible military applications of research results are considered to be the function of the Army and Navy. Expedition of the practical use in civil aeronautics of newly developed aircraft and equipment in so far as government assistance may be necessary is considered to be the function of the Civil Aeronautics Administration. The N.A.C.A. will use its own research facilities but will contract with university or other private research organizations for work in special fields, and the facilities of the National Bureau of Standards, Forest Products Laboratory, and other government research centers will be used by the N.A.C.A. whenever practicable. For important problems, whose practical solution appears to be especially difficult, parallel attack by several independent research teams is necessary. In those cases, N.A.C.A. laboratories, industry designers, Army, Navy, and Commerce groups, and individual scientists and inventors may work on various aspects of the same basic problem. These attacks must be co-ordinated, and it is the policy of the N.A.C.A. to achieve such coordination through the medium of subcommittees of experts representing all concerned.

A.I.E.E. Report on Electric Power Distribution for Industrial Plants

THE Committee on Industrial Power Applications of the American Institute of Electrical Engineers has issued a report of 109 pages entitled "Electric Power Distribution for Industrial Plants," which has been published by the Institute.

The report was prepared by more than 40 contributing authors who are electrical engineers engaged in industry, in the manufacture of electrical equipment, and in the service of public utilities. The following industries are represented: Aircraft, automobile, cable, chemical, copper, electrical equipment, factory insurance, mining, oil, photographic equipment, rubber, steel, and utilities.

It is stated that "the report is intended to promote the use of sound engineering principles in the design of electric-power-distribution systems for industrial plants and in the selection of equipment for these systems." The distribution system is considered "as extending from the point of entrance of the power company service or the generating bus to the terminals of the utilization devices," including high-tension substations, feeders, circuits, switch centers, and protective equipment.

The title page bears the statement: "This is not an A.I.E.E. Standard and the recommendations are not intended to be mandatory or restrictive."

The report may be purchased at $1 per copy. Address the Institute of Electrical Engineers, 29 West 39th St., New York 18, N. Y.

I.A.S. Confers Honors

AT a meeting of the Institute of the Aeronautical Sciences, New York, N. Y., January 31, 1945, the following awards and honors were conferred:

John Jeffries award to Air Marshall Sir Harold Whittingham, Director General of the Medical Services of the Royal Air Force, "for outstanding contributions to the advancement of aero medicine through medical research."

Sylvanus Albert Reed award to Fred E. Weick, chief engineer of the Engineering and Research Corporation," for his contribution to the development of tricycle landing gear and the two-control nonspinning airplane."

Octave Chanute award to Col. Benjamin S. Kelsey of the U. S. Army Air Forces, "for his outstanding contributions to the development of high-speed military aircraft and to the knowledge of the effects of compressibility through flight testing."

Robert M. Losey award to Dr. F. W. Reichelderfer, chief of the U. S. Weather Bureau, "in recognition of outstanding contributions to the science of meteorology as applied to aeronautics."

Lawrence Sperry award to William H. Phillips, head of the Stability and Control Flight Test Section, Langley Memorial Aeronautical Laboratory "for outstanding contributions in the field of stability and control of aircraft."

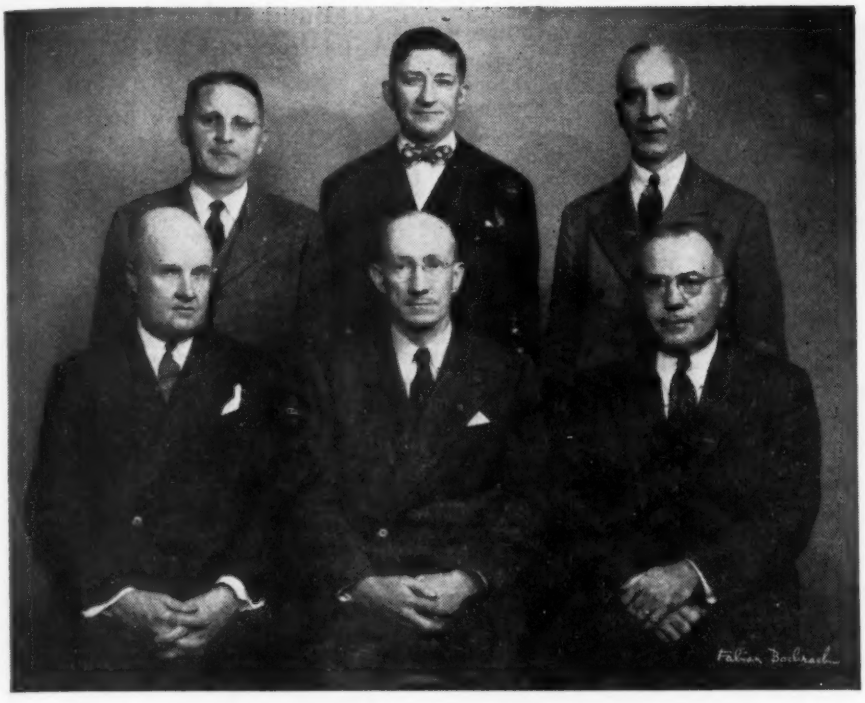
Honorary fellowship to Sir Frederick Handley Page, managing director of Handley Page, Limited.

American honorary fellow, Edward Pearson Warner, member A.S.M.E., vice-chairman of the Civil Aeronautics Board.

Honorary memberships were conferred on: Brig. Gen. F. O. Carroll, chief of the Engineering Division, Air Technical Service Command, U. S. Army Air Forces; Major Gen. Clements McMullen, Air Technical Service Command, U. S. Army Air Forces; J. Laurence Pritchard, secretary, The Royal Aeronautical Society; Brig. Gen. Eugen G. Reinartz, The Commandant, School of Aviation Medicine, Randolph Field, U. S. Army Air Forces; Dr. C. G. Rossby, director, Institute of Meteorology, University of Chicago.

Charles H. Colvin, member A.S.M.E., was inducted as president of the Institute for 1945.

New members of Council are: Rex B. Beisel, general manager of the Chance Vought Aircraft Division of the United Aircraft Corporation; George W. Brady, chief engineer of the Propeller Division, Curtiss-Wright Corporation; William K. Ebel, vice-president of Engineering, The Glenn L. Martin Company; Sherman M. Fairchild, associate member A.S.M.E., chairman of the board, Fairchild Engine and Airplane Corporation; Elmer A. Sperry, Jr., member A.S.M.E., vice-president, Sperry Products, Inc.



1945 STANDING COMMITTEE ON LOCAL SECTIONS

(*Front row, left to right:* Oliver B. Lyman, J. A. Keeth, *chairman*, and A. K. Mumford. *Back row, left to right:* S. D. Moxley, Ernest Hartford, executive assistant secretary, A.S.M.E., and L. E. Jermy.)

Among the Local Sections

President Alex D. Bailey Speaks at Chicago Section

IN his first local section appearance since his election, Alex D. Bailey, president A.S.M.E., spoke at the president's-night dinner and dance of the Chicago Section Jan. 11, at Hotel Stevens Towers. F. H. Lane, chairman of the Section, introduced William G. Abbott who was president of the A.S.M.E. in 1926. Mr. Abbott reviewed President Bailey's career, and then the Section Chairman introduced him. Mr. Bailey, after explaining that he had never wanted Mr. Abbott's job, just one like it, delivered an interesting address on the founding, organization, and the benefits of the A.S.M.E. He mentioned the fact that several Chicago engineers had occupied the presidency of the Society before him. He urged the wives of members to see that their husbands attended meetings of the Society and engaged in its activities. The evening's entertainment was arranged by R. H. Bacon, chairman of the Dinner and Entertainment Committee.

On January 23 the Section held a four-part meeting sponsored by the Junior Division, consisting of a tour of the magnesium-alloy foundry and machine shop of Hills-McCanna Co., Chicago, Ill., exhibit of samples of sand, die, and permanent-mold castings, sheet, rod, tubing, etc., at the Imperial room of the Belmont Hotel, and dinner at the same hotel. Speakers at the dinner were Dan W. Moll, vice-president and treasurer, Hills-McCanna Company, and chairman of Sand Cast Division of Magnesium Association; and Oscar Blohm, chief metallurgist, Hills-McCanna Co. Both these speakers have had wide experience in the production of magnesium-alloy sand castings. Following the dinner two sound motion pictures were shown—"Magnesium, the Metal From the Sea," and "The Working of Magnesium."

Baltimore Section Meets To Hear Douglas C. Turnbull

"What Is Ahead for the Railroads" was the subject chosen by Douglas C. Turnbull for discussion at the January 22 meeting at the Engineers Club of Baltimore, Baltimore, Md. Mr. Turnbull outlined in detail the new forms of competition which may be expected and the problems which will confront the railroads in attracting business from the other forms of transportation and still maintain an economic balance. An interesting question period followed, shared by the 73 members and guests.

C. A. Gladman Heard at Boston Section

On January 25, at Northwestern University, Boston, Mass., the Section heard C. A. Gladman, National Physical Laboratory, England, speak on "Drawing-Room Practice in Relation to Interchangeable Components." He showed, with the use of slides, current methods of dimensioning for interchangeable parts and the proposed datum plane method. This method made it possible not only to design for tolerances and for interchangeable parts but also greatly simplified jig design and inspection-gage design. Members and guests totaled 130.

Central Illinois Section Hears Donald M. Hobart

"Designs for Living" was the subject of a talk by Donald M. Hobart, manager research department of the Curtis Publishing Company, at the January 11 meeting held at the Jefferson Hotel, Peoria, Ill. Mr. Hobart pointed out that never before have consumers accumulated so many wants and needs for products of the building, appliance, and home-furnishing industries. This, he said, was a great challenge to industry because the merchandise to be purchased after the war will be quality products, and that 45 to 75 per cent of the items will be purchased within two years after the products are available.

"Paths to Smoke Abatement" at Central Indiana Section

City officials, representatives of the coal industry, engineers, news writers, and interested citizens were among the 70 persons attending the January meeting of the Central Indiana Section, at Indianapolis, Ind., to hear Ralph Sherman, supervisor of the Fuels Division of Battelle Memorial Institute outline the steps to be taken in reducing the amount of smoke in industrial cities. In his talk Mr. Sherman stressed the importance of strict enforcement of a city ordnance based on sound engineering practice, and said that proper firing methods combined with proper equipment need not inflict a hardship upon either the citizens or industrialists. He said that private homes offer a greater problem than industry but equipment for homes has been designed that will burn coal smokelessly. The complete answer for any city, he stated, is not in burning the low-volatile, so-called smokeless fuels, as only a small percentage of all coal is of this type, and the entire output of the country would not supply three of our larger cities. A discussion period lasting two hours followed the lecture.

Central Pennsylvania Section Hears Talk on Electronics

The meeting held by the Section on January 23 at the Electrical Engineering Building was open to the public with special invitation to the Centre County Engineers Society and the Engineering Societies of State College. L. W. Ballard, General Electric Company, gave a lecture on "Electronics as Applied to Industry," illustrating with slides and demonstration equipment.

"Electric Strain Gages" Subject at Cleveland Section

A description of the theory, operation, and

application of electric strain gages was given by Francis G. Tatnall of the Baldwin Locomotive Works, Philadelphia, Pa., at the January 11 meeting of the Section, held at the Cleveland Engineering Society, Cleveland, Ohio. To a total of 150 members and guests Mr. Tatnall spoke for two hours. His talk was instructive, interesting, and entertaining and the Section considered this meeting an outstanding one.

Talk by James H. Herron at Columbus Section

James H. Herron, president, James H. Herron Company, Cleveland, Ohio, and a past-president of the A.S.M.E. was the speaker at the January 10 meeting of the Columbus Section at the Battelle Memorial Institute, Columbus, Ohio. Mr. Herron's important positions on many civic bodies in Cleveland, his work as head of the research and testing laboratory in Cleveland which bears his name, and his active membership in the A.S.M E. have given him a broad background for the subject of his talk on "The Civic and Political Responsibilities of the Professional Engineer." A discussion period followed Mr. Herron's talk.

On January 17 the Section heard C. A. Gladman of the National Physical Laboratory, England. His paper "Drafting-Room Practice in Relation to Interchangeable Components" was the result of a study and recommendation made by a special service committee on drafting practice set up by the British Admiralty. Fifty-five attended the meeting.

Dayton Section Hears C. Allen Fulmer

"Centrifugal Casting" was the subject discussed by C. Allen Fulmer at the January 16 meeting of the Dayton Section at the Engineers Club, Dayton, Ohio. Mr. Fulmer covered some of the various problems which must be overcome, and a very interesting question period followed his lecture.

At the meeting of January 18, held at the Engineers Club, C. A. Gladman presented a very interesting paper on "Standardizing Drafting Room Practice." A discussion period followed Mr. Gladman's reading, in which 35 members and guests took part.

Detroit Section and S.A.E. Hold Joint Meeting

The Detroit Section held a joint meeting with the S.A.E. on Jan. 12 at the Book-Cadillac Hotel. The speaker was C. A. Gladman, National Physical Laboratory, England. He discussed drawing-office practice in relation to interchangeable components, based on service conditions and the economy of manufacture and inspection, as well as the basic principles involved. Two hundred and fifty were in attendance.

"War Welding and Future Peacetime Welding" was discussed by J. W. Diebold, welding engineer, General Motors Truck & Coach Division, at a meeting of the Junior Detroit Section on Jan. 16 at the E. S. D. Building, Detroit.

At the January 25 meeting held at the Engineering Society of Detroit Building, Detroit, Mich., O. E. McCollum, general manager, Central District, Transcontinental & Western Air Lines, discussed "Postwar Transportation," illustrated with a domestic and international technicolor film of a four-motor plane trip from New York to Los Angeles. Members of the Detroit Metropolitan Aviation Planning Authority were guests of the Section. The meeting was handled by the liaison officer of the Transportation Division.

Process and Firing of Coal at East Tennessee Section

The Section heard L. A. Shipman, combustion engineer, speak on "The Processing and Firing of Coal," at their January 25 meeting at the University of Tennessee, Knoxville, Tenn. Mr. Shipman discussed the solutions to some of the more common firing problems found in industrial power plants.

Inspection of Surface Finish Subject at Milwaukee Section

Louis M. Nielsen of the General Electric Co. was the speaker at the Milwaukee Section meeting on Jan. 10 at the City Club, Milwaukee, Wis. Mr. Nielsen discussed the advantages and disadvantages of the various types of instruments which have been developed for inspection of surface finish and described the method developed and used by the General Electric Co. which is based on sight and feel comparison between a master surface and the surface under inspection. A total of 85 attended.

Mid-Continent Section Features Oil Industry

Eighty members and guests of the Mid-Continent Section met at the Mayo Hotel on Jan. 25 to hear Nelson Turner, chief process engineer, Jones & Laughlin Co., speak on recent developments in the oil and refinery practice and discuss some of the many phases shown in a sound film "Evolution of the Oil Industry." The four reels of the film portrayed the development of the oil industry from the earliest times to the modern- equipment and processes used in drill work, production, refinery practice, transportation of raw and finished products, research, and marketing.

New Haven Section and Yale Branch Hear J. D. Hopkins

The New Haven Section held a joint meeting with the Yale Student Branch on Jan. 10 at Mason Laboratory, Yale University, New Haven, Conn. J. D. Hopkins (Yale '45) Yale School of Engineering, spoke on "Electronics in Industry" and gave examples of various present industrial uses as well as predictions for the future; he stressed the three outstanding qualities of electronics—speed, dependability, and accuracy. The second speaker, Ira T. Hook, research engineer, American Brass Company, discussed "Copper Goes to War." He pointed out three things copper alloys offer—workability, durability, and wearability and showed a motion picture of Canada's wartime production of copper products.

E. G. Budd and C. A. Gladman Speakers at Philadelphia Section

The Section heard E. G. Budd, A.S.M.E. Medalist, 1944, read a paper on "A New Era Has Come for the Railroads," at the January 23 meeting at the Philadelphia Engineers Club, Philadelphia, Pa. In his article, Mr. Budd said that the world has become more travel-conscious because of war and all forms of transportation will later benefit. He visioned lightweight high-speed comfortable trains in the future.

Lee N. Gulick was presented with the A.S.M.E. certificate of citation for faithful service to the Section.

On January 29 in both the afternoon and evening, C. A. Gladman, Scientific Officer, National Physical Laboratory, England, read a paper before the Section entitled "Drawing-Office Practice in Relation to Interchangeable Components," describing the work of a special service committee on drafting practice set up by the British Admiralty and originally presented to The Institution of Mechanical Engineers, London, England.

Plainfield Section Hears Islyn Thomas

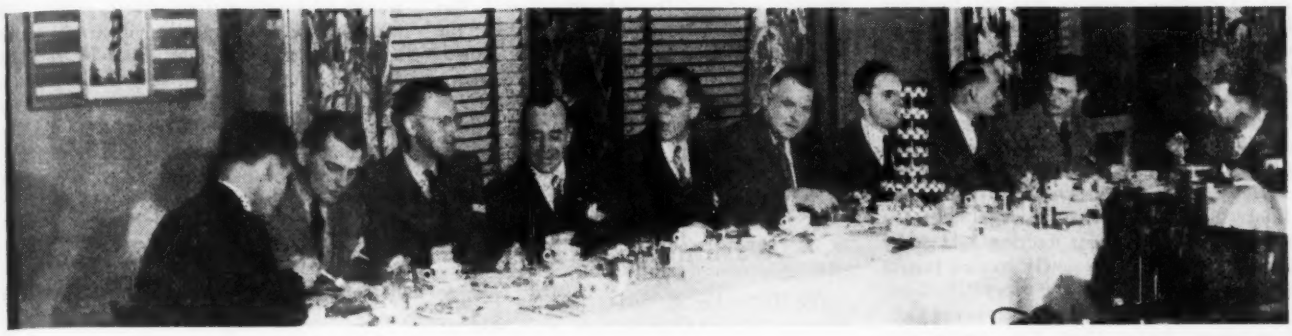
"Plastics" was the subject discussed by Islyn Thomas, president, Thomas Manufacturing Company, at the Jan. 17 meeting of the Section at the Park Hotel, Plainfield, N. J. Mr. Thomas explained the various types of plastics and their application, the method of molding plastics, and showed samples of the methods used. His talk was followed by a film entitled "The Shape of Things to Come" furnished by the Boonton Moulding Company.

Raleigh Section Meets With North Carolina Society of Engineers

The Raleigh Section met with the North Carolina Society of Engineers on Jan. 26 and 27 at Hotel Sir Walter, Raleigh, N. C. Among the speakers at the session was Ole Singstad, consulting engineer, New York, N. Y., who talked on tunnel construction and problems on ventilation during erection and during operation. He discussed particularly the Queens and Holland tunnels, and the mechanical engineers were especially interested in the "locking-in" and "locking-out" arrangement of the workers in high-pressure areas, and in the laws concerning the sand-hog laborer. Other speakers were Edward Larson, National Society of Professional Engineers, J. E. Dunn, district engineer, Portland Cement Association and H. E. Hilts, Public Roads Administration, Washington, D. C. At the informal banquet, A. C. Horrocks, Goodyear Tire & Rubber Co., Akron, Ohio, addressed the members on "Reconversion," and at the Saturday morning session Thos. P. Pendleton, U. S. Geological Survey, Washington, D. C., spoke on "New Methods of Making Maps."

Rock River Valley Section Hears J. D. Swannack

A dinner meeting was held by the Section on January 27 at the Hotel Hilton, Beloit, Wis.,



SPEAKERS' TABLE AT ROCK RIVER VALLEY SECTION, JAN. 27

(*Left to right:* J. W. Medlin, Madison, Wis.; H. R. Puckett, Madison, Wis.; K. H. Casson, Rockford, Ill.; Lloyd Hornbostel, Beloit, Wis.; W. C. Fischer, chairman; J. D. Swannack, speaker; R. J. Cramer, chairman, Milwaukee Section; E. L. Dahlund, D. K. Hart, and K. W. Schultz, all of Beloit, Wis.)

when the 80 members and guests heard J. D. Swannack, design calculator, Fairbanks, Morse & Company speak on "Instrumentation for Measurement of Vibration." Mr. Swannack outlined vibration problems encountered, particularly with reference to torsional vibrations on Diesel engines, and supplemented his talk with models. Then followed a description and demonstration of mechanical instruments used for measurement and analysis of vibrations. Mr. Swannack described vibration as a periodic motion, and said that the instruments now in use for vibratory problems are fashioned on those used for measurement of earthquakes, some of which are so delicate that they will record a one-inch tilt of the earth within 8000 miles. The discussion period lasted over an hour.

St. Joseph Valley Section Hears Talk on Shot Peening

John C. Straub, research engineer, American Foundry & Equipment Co., addressed the January 24 meeting of the Section at Hotel Hoffman, South Bend, Ind., on the subject of Shot Peening and Fatigue of Metals. He explained that shot peening as used very definitely increases fatigue resistance of gears and springs, and that broken shot are a very definite feature which will reduce the amount of resistance to fatigue. He was followed by Prof. C. C. Wilcox who gave an informal talk on Temperature and Engineering, and told of his experiences as chief engineer on the Canal Project.

Annual Ladies' Night at San Francisco Section

The San Francisco Section held its annual ladies' night on Dec. 28, 1944, at the Engineers' Club, San Francisco, Calif. The evening was spent pleasantly with a magic performance by Carolyn Trask, music provided by the wife of one of the members, Mrs. Jones Stipek Salveson, a technicolor sound movie, and a humorous-story contest in which extemporaneous speakers told their favorite amusing stories, after which the applause for each story was recorded on a general radio sound level meter. This means of judging a contest appealed to the engineering-minded audience.

On January 25 the Section held a joint meeting with the San Francisco Engineering Council at the Pacific Gas and Electric Co. auditorium, San Francisco, Calif., when F. T. Letchfield, consulting engineer and assistant vice-president, Wells-Fargo Bank and Union Trust Company, spoke on "Current Outlook From an Engineer's Viewpoint." After a wide experience in consulting work both at home and in Europe, Mr. Letchfield was made consultant to the Office of Scientific Research and Development, Washington, D. C., and is at the present time subject to call by the director of that organization.

Southern California Section Celebrates Thirtieth Anniversary

The thirtieth anniversary of Southern California Section was celebrated with a dinner meeting on January 24 at the Friday Morning Club, Los Angeles, Calif. Many of the past chairmen of the Section were present, including Col. Walter Holbrook Adams, first chairman for the year 1914-1915, who is still an active and valuable member. The following letter to Ray G. Roshong, chairman of the Section, from A.S.M.E President Alex D. Bailey was read:

Dear Mr. Roshong:

Since receiving your kind invitation of December 28 to attend your Thirtieth Anniversary meeting, and the personal invitation from Mr. Armstrong by phone, I feel that this occasion deserves a better answer than the one I sent you in my brief letter of January 2.

In the life of any organization, particularly one in your part of the country, a 30th anniversary is an occasion for considerable pride, and is something to be talked about. I had not realized that your section had been operating so long. Although a 30th anniversary may not mean much to those on the Eastern Seaboard, we in the Middle West still consider it a notable attainment.

I wish that conditions were different so that one could get around the country more easily, but difficulties and restrictions of traveling have made it practically impossible to do any visiting and I am confining my activities in that line to regular trips to New York Headquarters for Executive Committee meetings, and for other special meetings in New York or Washington which occur from time to time. Let us hope that before the end of the year things will be better.

Let me congratulate your Section on having completed 30 years of activity in your profession and service to it and to the public; and best wishes for your continued success. I am sure I speak for members of Council and the membership at large in sending you this message.

Sincerely yours,

ALEX D. BAILEY, President, A.S.M.E., 1945

Another meeting was held by the Section on Dec. 29, 1944, at the Los Angeles Athletic Club, Los Angeles, Calif., when Dean Geo. L. Sullivan and Prof. R. L. Daugherty addressed the members. A group discussion on the sub-

AUDIENCE AT ROCK RIVER VALLEY SECTION MEETING OF JAN. 27

(Part of the audience intently watching the speaker, Mr. Swannack, making adjustments on some of the instruments.)

ject of student branches was led by Dean L. M. K. Boelter, recently appointed dean of the College of Engineering, University of California, Los Angeles, Calif. At a dinner meeting on January 2, also held at the Los Angeles Athletic Club, there was a group discussion on A.S.M.E. affairs and an informal address by Dean Robert L. Sackett, representing the A.S.M.E. On January 12, at a dinner meeting at the Clark Hotel, Los Angeles, Calif., the first meeting held under the sponsorship of the newly created Instruments and Regulators Professional Division, S. G. Eskin, director, the members heard L. F. Richardson, Bailey Meter Co., review two papers which were given at the Annual Meeting in New York, N. Y., 1944, by members of his company, "Electronic Instruments for Industrial Processes," prepared by R. E. Sprenkle; and "Piping Arrangements for Acceptable Meter Accuracy," prepared by P. S. Dickey and A. J. Hornfeck. The reviews were illustrated by stereoptican slides and very favorably received. A total of 200 heard the reviews.

Cooling Towers Subject at South Texas Section

Dr. Joseph Lichtenstein of the Foster-Wheeler Corporation, New York, N. Y., was the speaker at the January 18 meeting of the South Texas Section at Rice Hotel, Houston, Texas. In his talk entitled "Performance and Selection of Mechanical-Draft Cooling Towers," Dr. Lichtenstein urged the adoption of a common basic theory and standardization in cooling-tower practice to correlate the vast amount of experimental data and practical experience now available. He discussed problems confronting the users of cooling towers and illustrated the talk with lantern slides. Seventy members and guests were present.

Joint Meeting of Utah Section and A.I.E.E.

Colored moving pictures of Old Mexico were enjoyed at the meeting on Jan. 24 at the University of Utah, Salt Lake City, Utah, when R. A. Marriott, engineer, western department, American Smelting & Refining Company, discussed, his trips to Mexico. Mr. Marriott had collected the pictures over a period of three years, and his oral and visual description of the architecture, culture, scenic and historical ruins of Mexico made a most interesting evening. This was a joint meeting with the A.I.E.E., and also ladies' night.

Washington, D. C., Section Celebrates Twenty-Fifth Anniversary

The 25th anniversary banquet of the Washington, D. C., Section was held on Jan. 11 at the Roger Smith Hotel, Washington, D. C. Dr. H. L. Whittemore, fellow, A.S.M.E., chief, engineering mechanics section, National Bureau of Standards, Washington, D. C., discussed the past history of the section, as did Ernest Hartford, executive assistant secretary, A.S.M.E. Col. C. E. Davies, secretary, A.S.M.E., talked of the future of the Society, and Dr. M. A. Mason, member, A.S.M.E., principal engineer, Beach Erosion Board, War Department, Washington, D. C., discussed the plans of the local section for the present as well as the future. Following the speakers, the members were entertained with music and a Navy film "Return to Guam."

Glass-Blowing Machinery Subject at Western Washington Section

The December 6, 1944, meeting of the Western Washington Section was held at Gowman Hotel, Seattle, Wash., when Ed Campbell gave an interesting talk on the history of glassmaking and the evolution of glass-blowing machinery. After the meeting, a field trip was taken to the Northwestern Glass Company's plant where operations in connection with the production of beer, whiskey, and Purex bottles were inspected.

The January 24 meeting held at the Chamber of Commerce, Seattle, Wash., featured W. W. Offner, of the Industrial X-Ray Engineers Company, who explained the use and application of X-ray, Gamma-ray, and magnetic inspection methods to castings, welds, etc. Otis F. Lamson also gave a short talk on "The State of Washington Professional Engineer's License."

Postwar Readjustment Problems Discussed at West Virginia Section

At the meeting on January 23 at the Daniel Boone Hotel, Charleston, W. Va., the Section heard Dr. Emory Q. Hawk, consultant principal economist of the Bureau of Labor Statistics, U. S. Department of Labor, explain how surveys of present trends of thought among business leaders and executives were made to compile data on postwar employment and business activity trends. Dr. Hawk illustrated, by means of visual charts, graphs, and maps, the vast changes in industrial activity and employment brought about by the war and the estimated adjustments from wartime to a civilian peacetime economy. He said that studies being made by industry indicate they intend to employ all ex-service men and most of the war-industry workers. Forty-five members and guests attended.

Worcester Section Holds Steam Power Plant Symposium

A Steam Power Plant Symposium was held by the Worcester Section on Jan. 11 at Worcester Polytechnic Institute. Guests included engineers from the principal power plants in Worcester County.

Ollison Craig, engineering manager; L. V. Andrews, chief operating engineer; Max H. Kuhner, chief mechanical engineer; Wayne C. Rogers, development engineer, all of the Riley Stoker Corporation, were the speakers.

Mr. Craig outlined the information necessary to properly design steam-generating equipment and discussed present-day fuels available for power-plant use. Mr. Andrews reviewed the difficulties encountered in obtaining and keeping and training power-plant employees during present wartime demands for men. Mr. Rogers described the various methods of testing and developing pulverized-fuel-burning equipment. Mr. Kuhner discussed the difficulties experienced in superheaters used in high-temperature and high-pressure installations and the corrections available through the use of present-day materials.

During the discussion period furnace explosion hazard present with pulverized fuel was reviewed, with suggestions offered as to the best methods of prevention.

Progress made in steam washing and in the development of portable package type of boilers, and the increasing use of the Dowtherm boiler for certain operations, were briefly reviewed.

Modern Steel Mill Technique to Be Discussed at Meeting of Junior Metropolitan Group on March 27, 1945

ALL engineers, as well as mechanical engineers, will be interested in the subject of the March 27 meeting of the Metropolitan Junior Group. The topic is "Modern Steel Mill Technique" which should be of considerable interest to all concerned with present-day methods for stepping-up production.

Martin J. Conway Speaker

MARTIN J. CONWAY

Mr. Conway, who is manager of the Petroleum Division of Lukens Steel Company, hails from England and is a graduate of Oxford University in mechanical and chemical engineering. Before coming to this country, he obtained considerable experience in England with tar distillation and by-products of iron and coal works. After being associated with various steel companies in the United States as fuel engineer, he became associated in the same capacity in 1926 with his present employer. He transferred to the sales department as special engineer in 1940 and just recently has been appointed to his present position.

"World's Largest Plate Mill"

He is credited with the invention of the recuperative open-hearth furnace and improved methods of manufacturing of wrought-iron and metallic iron properties. He is now concerned with special problems covering the application of steel. Mr. Conway is also the author of numerous papers on fuel economy, liquefied petroleum gases, uniflow engines, and many other subjects. He is a member of the A.S.M.E. and of many other professional societies.

His talk will be built around a film entitled "World's Largest Plate Mill" which shows the casting in the open hearth of a 110,000-lb ingot and its subsequent rolling on the 206-in.

mill of the Lukens Steel Company to form a steel plate having a shipped weight of 76,000 lb. The film also depicts the spinning of a head over 18 ft in diam, one of the largest ever formed anywhere, and the pressing of head sections from steel plate $3^1/_2$ in. thick. Some appropriate slides will be shown accompanying a short talk following the showing of the film. An open discussion and question period will follow the talk. It is readily seen that, because of Mr. Conway's wide and practical experience, this meeting will provide an exceptional opportunity for engineers in the New York area to get some up-to-date facts and information on this subject.

Dinner To Precede Meeting

The meeting will be held at 7:30 p.m. in the Upstairs Dining Room of Childs Restaurant at 109 West 42nd Street and will be preceded by an informal get-together at 6:00 p.m. followed by dinner at 6:30 to which all are invited. The charge for dinner will be $1.25 per person. Those who cannot attend the dinner are cordially invited to come to the meeting. The meeting is in charge of Edward S. Rowell.

With the Student Branches

University of Alabama Branch

The first 1945 meeting of the Branch was held on January 16 at the new Engineering Building. The program consisted of two short educational movies, one on Heat Engines, the other on Thermodynamics. Officers for the new quarter were elected: Bryan H. Stanley, chairman; Jerome M. Raudman, vice-chairman; Margaret Robb Shook, secretary; Murry Maisel, treasurer. Donald H. Shenk was recommended for appointment as honorary chairman.

University of California Branch

A joint meeting was held with the A.I.E.E. on January 17, at the Engineering Building, University of California, with Kenneth Straney of the A.I.E.E. presiding. The speaker was John Bailor, General Electric Company, whose subject was the "Turbo-supercharger." Mr. Bailor explained its advantages in attaining rated horsepower in high-altitude flying and illustrated the principal elements of the supercharger with the aid of a cutaway model.

Cornell University Branch

Three members of the class of '46 spoke at the meeting on December 27 at Sibley College, in the A.S.M.E. contest. Professor Brown of the Arts College and Professor Goodier, head of the department of machine design, judged the speeches. Illustrating with blackboard diagrams, Saul Levinson spoke on "Balancing Rotating Machines" and presented an interesting account of some of the problems that he had faced while working for the Westinghouse Company. "Coal Segregation in Boiler Plants" was the subject chosen by John Kreuter, who illustrated his talk with material and slides from the November, 1944, Mechanical Engineering. Frank King spoke on the use of gaseous fuels in Diesel engines.

At the meeting on January 10 the members were shown films of prewar life on the campus and various shots of the armed services, in place of the sound film in technicolor entitled "Boulder Dam" which because of the weather conditions did not arrive in time.

Duke University Branch

The Branch held a meeting on January 9 at the Asbury Building, Duke University, to discuss an inspection trip to the North Carolina Ship Building Company. A. J. Steele was appointed to head a committee for the "Prof. Roast." Two General Motors films were shown, "Where Mileage Begins," and "Diesel, the Modern Power." These films were obtained through J. P. Proctor, a Navy V-12 student at Duke.

Drexel Institute of Technology Branch

The Branch held its annual joint meeting with the Junior Section and the Villanova College Student Branch on January 10 at the Drexel Student building. Among the visitors were: Professor Riddle, honorary chairman of the Drexel Branch; Prof. J. Stanley Morehouse, dean of engineering at Villanova College; Frank Ptansig, chairman of the Junior Section, and members of the Villanova Student Branch and of the Junior Section. Mr. Ptansig invited all student members to the meetings of the Junior Section held in the Engineers Club, Philadelphia, Pa. Mr. Scott of SKF Industries gave a talk on "Quality Control," with special emphasis on its application in the production of roller ball bearings.

Illinois Institute of Technology Branch

A regular meeting of the Branch was held at the Sigma Xi fraternity house, Illinois Institute of Technology, Chicago, Ill., on Jan. 10, when Prof. Henry L. Nachman presented the first part of a talk entitled "The History of the Steam Engine," accompanied by historical slides. Part two will be given at the next meeting of the Branch.

Arrangements were announced for a trip to

STUDENT BRANCH AT THE UNIVERSITY OF KANSAS

(*Front row, left to right:* W. G. Widden, R. Reidel, assistant instructor; E. G. Luehring, Prof. R. S. Tait, W. L. Siegerist, chairman; M. L. Hicks, honorary chairman; Prof. E. S. Gray, F. Darden, R. S. Stockton, vice-chairman. *Second row:* R. A. Kerr, H. A. Dalby, secretary; J. E. Illgner, W. S. Hobbs, H. J. Hoody, F. M. Daneke, R. F. Nelson, K. C. Mattley. *Third row:* J. R. McShane, J. C. Ethridge, R. A. Miller, M. D. Chase, R. T. Neustrom, D. Cousins, J. N. Baker, R. J. Unger, D. F. Smalley. *Fourth row:* L. C. Brown, J. Thiele, D. L. Ried, W. R. Seever, C. R. Ball, F. C. Davis, J. Palmer, L. L. Leigh. *Fifth row:* B. P. Crass, N. L. Conley, N. D. Blair, J. E. Simpson, S. E. Dickey, J. R. Murray, J. F. McGucken, J. R. Shachelford. *Sixth row:* P. A. Finch, W. D. Miller, D. A. Arata, J. Kendrick, L. L. Mische. *Seventh row:* J. F. Rednickey, T. R. Botts, R. F. Ellsworth, treasurer; E. B. Shive, J. V. Selde. *Members not present:* J. W. Riehl, J. R. Gregath, S. S. Fleener, C. E. Smith, M. P. Fryar, R. E. Smith, A. D. Talbot.)

the South Works of the Carnegie-Ill. Steel Corporation plant in South Chicago, Ill., on February 15 for junior and senior mechanical engineering students.

Iowa State College Branch

At a meeting of the Branch at Ames, Iowa, on November 29 suggestions for future meetings were asked for. Professor Grace suggested that students give talks on engineering subjects as preparation for the spring trip to Chicago, Ill. A film on gas turbines was requested and a further suggestion was made that speakers be secured to lecture on technical subjects. Following the meeting, a film on lubrication was presented.

On January 18 the Branch met to hear Professor Ryder of the electrical-engineering department give an interesting talk on "Electronics, Electronic Devices and their Applications."

Kansas University Branch

At the December 1, 1944, meeting of the Branch, officers were elected for the current semester: Walter L. Siegerist, student chairman; R. S. Stockton, vice-chairman; Harry A. Dalby, secretary; Robert Ellsworth, treasurer. It was decided that the tradition of "Engineers' Day" March 17, should be started again at Kansas University, and a committee was named to act on this, consisting of J. F. McGucken, J. R. Murray, J. E. Simpson, and C. E. Smith. A group picture was taken for the school yearbook and for MECHANICAL ENGINEERING.

Lafayette College Branch

Two meetings were held in January by the Branch; the first on Jan. 12 at Markle Hall featured a lecture by H. E. Linsley of the public relations department, Curtiss-Wright Aeronautical Corporation. His subject, "Aviation Today and Tomorrow," was of great interest to the audience. An open discussion followed the lecture. Mr. Linsley is an excellent speaker and the Branch recommends him to other branches.

The second meeting on January 16 at Pardee Hall was held with the Lafayette College Branch of the A.I.E.E. Three motion pictures from the Bell Aircraft Corporation of Buffalo, N. Y., were shown—"Cannon on Wings,—the Bell Aircobra;" "The Bell Helicopter," and "B-29's Over Dixie." These films illustrate the tremendous amount of planning that enters into the production of our current military aircraft.

A joint meeting with the Student Branch of the A.I.E.E. was held on January 17, when three of the latest movies in the field of aviation were shown.

Lehigh Branch

The Branch held its first meeting of the current semester on December 13, 1944, when the new officers were introduced: Martin Brossman, president, Joseph Rengert, vice-president, Willard Murray, secretary, and Lido Iacocca, treasurer. An illustrated lecture by Kermit Fischer of Fischer-Porter Flow Meter Co. on "Variable Area Flow Meters" followed. Mr. Fischer explained the purpose of the rotameter, its history, and its use in planes to cut down the gas consumption. He said that the development of the rotameter was not nearly as important as the fact that glass tubing can be manufactured with an extremely small inaccuracy tolerance and that glass products will become very important after the war.

University of Michigan Branch

The December 13 meeting was held in the West Engineering Building, when Professor Schwartz, honorary chairman, gave a report of the Annual Meeting of the A.S.M.E. in New York, Nov. 26–Dec. 1, 1944. The speaker for the evening was Professor Sherlock of the civil engineering department. His subject was "Effect of Collective Bargaining on Engineers." Professor Sherlock is a member of a committee appointed by the A.I.C.E. for the investigation of the possibilities of organizing professional men as a protection from the unions and employers alike.

New officers were elected at the January 11 meeting held in Michigan Union, as follows: William D. Pittsley, president; William M. Dull, vice-president; John H. Oxley, secretary-treasurer. It was voted to have a photograph of members of the branch in the Michigan "Ensian." Moving pictures were shown of a trip on a Hudson Bay Company supply ship to the Eastern Arctic Regions taken and narrated by Professor Scherzer.

On January 24 at Michigan Union the Branch met to hear Professor Firestone lecture on "The Supersonic Reflectoscope," an instrument for detecting flaws in metals. The reflectoscope was invented by Professor Firestone and was tested in the Physics Laboratory at the University of Michigan. The lecture was illustrated with slides.

Michigan State College Branch

New officers were elected at the November 28, 1944, meeting of the Branch, at the Union Building, as follows: William Miller, chairman, Constance Hutty, secretary, Melvin Lill, treasurer.

University of New Hampshire Branch

In November, 1944, the Branch held its first meeting of the semester when two films from the U. S. Department of the Interior in cooperation with the Standard Oil Company of Indiana, were shown—"The Story of Gasoline" and "Automobile Lubrication." The winner of the Marks Handbook prize for the best student paper presented during the summer meetings was Leon Grodzins. His paper was entitled "Einstein's Theory of Relativity."

Northeastern University Branch

Featured at the January 16 meeting of the Branch, attended by thirty-two members and guests, was a G.E.-Alco film entitled "Railroadin'," which traced the growth of railroads in the United States from early days to the modern maze of steel highways crisscrossing the nation.

On January 23 members of the Branch were conducted on a tour of the Christian Science publishing house in Boston, Mass., home of the *Christian Science Monitor*. Of special interest to the students in this establishment, reputed to be the cleanest printing place in the world, were the number of cams and other mechanisms that make the operation of the presses almost automatic. The students also viewed the Mapparium, a huge facsimile of the globe.

Ohio State University Branch

The first meeting of the winter quarter was held on Jan. 5 at Robinson Laboratory. A tentative program for the quarter was set up, speakers suggested, and three trips planned.

At the second meeting, January 12, at Robinson Laboratory, the treasurer's report was given, and after the business meeting was over, the members went to the Communications Laboratory where Dr. Albert Prebus of the department of electrical engineering lectured on and demonstrated the electron microscope.

A visit to the Betatron Laboratory on the campus of the University was made on January 19, when Dr. Wang of the department of electrical engineering, explained the devices in the laboratory.

University of Oklahoma Student Branch

On December 1, 1944, in the Engineering Building Auditorium, the Branch met and elected new officers as follows: B. G. Thacker, president; R. C. Hightower, vice-president; E. W. Gray, Jr., secretary-treasurer; and J. W. Hinckley, St. Pat's council representative. Plans for the Engineering Open House were discussed and E. W. Gray appointed director of the mechanical engineering phase.

The Annual Engineers' Open House was held on December 15 in the engineering buildings—the third wartime open house held at the University. About 3000 people attended. The entire mechanical-engineering laboratory facilities were open for inspection, with special exhibits of the C.F.R. test unit, electric lighting plant, Wind Tunnel, and numerous aeronautical engines. A self-contained air-conditioning unit of latest design was on display, also a year-round direct expansion electric-driven compressor air-conditioning unit; the new gas-fired year-round Servel air-conditioning unit with diagrammatic colored charts to explain its cycle of operation; a model of a complete gas-turbine powered generating station sent by Allis-Chalmers Corporation, an armament display sent by the United States Navy, and other special exhibits.

University of Pennsylvania Branch

A joint meeting of the A.S.M.E., A.I.E.E., A.S.C.E., and A.I.Ch.E. chapters was held on January 9 at the engineering building, sponsored by the Pennsylvania Branch. R. G. Maxwell of the General Electric Company spoke on "The Industrial Applications of Electronics," illustrating his talk with slides. Two cartoon films were then shown. The lecture hall was filled to capacity.

Purdue University Branch

Prof. H. L. Solberg, head of the School of Mechanical and Aeronautical Engineering, Purdue University, presented postwar plans for the further development and expansion of the Mechanical and Aeronautical Engineering School at a meeting of the Branch on Jan. 3 in the mechanical engineering building.

The need for extensive expansion was explained by the fact that student enrollment in the University is expected to increase to 150 per cent of the prewar enrollment, due to the G.I. Bill of Rights which will enable many service men to continue their technical training in both undergraduate and graduate fields of learning. A large increase in graduate enrollment is also expected because of the large number of graduate fellowships which will be made available after the war. Other anticipated postwar conditions point to the need for expansion.

Rice Institute Branch

Paul R. Sidler, resident engineer of New York, N. Y., and American representative of Brown, Boveri & Company, of Switzerland, gave an unusually interesting lecture on "Gas Turbines, Their Development, and Operation," at the January 11 meeting. Members of the Southwest Section of the A.S.M.E. were guests of the Branch.

Santa Clara University Branch

During the last semester the Branch made inspection trips to the Food Machinery Company, San Jose; Bethlehem Steel Company, Southern San Francisco; and Joshua Hendy Iron Works, Sunnyvale, Calif. At the plant of the Food Machinery Company the students saw the various steps involved in the assembling of amphibious tanks and were later given a ride in one of the tanks. At the Bethlehem Steel Company's plant the students were shown metal being purified in the open-hearth furnace and then poured into sand pits and ingots, and also the delicate instruments used in securing photographs of the grain structure of the different types of steel and other alloys. Frank Basye, a metallurgist in the employ of the company, was the guide. At the Joshua Hendy Iron Works the students were impressed by the magnitude of the plant and the many large machines in operation.

An engineer of the Food Machinery Company, F. Bowie, spoke to a group of mechanical engineering students on fog-fire fighting apparatus.

University of Southern California Branch

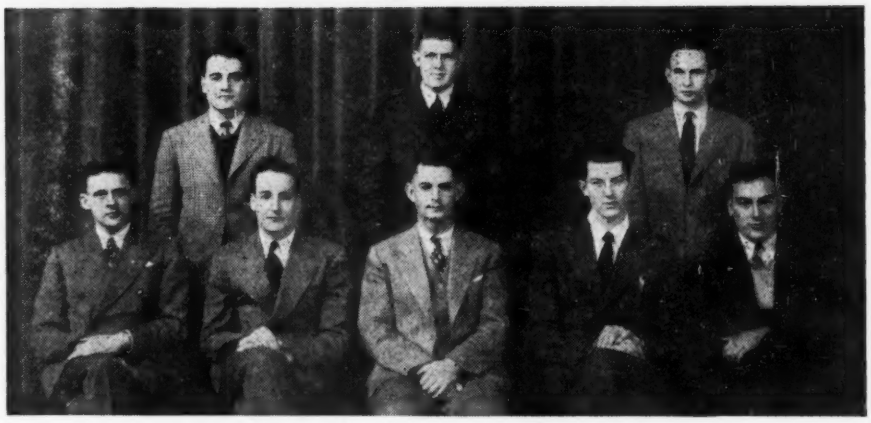
The Branch had a busy month in January, beginning with a meeting on Jan. 5 in the engineering building, when the speaker was Lieut. (j.g.) Robert G. Partridge, a graduate in mechanical engineering of U. S. C. Lieut. Partridge described the training that the Navy V-12 personnel will encounter upon graduation. He told some very interesting facts of his experiences with steam engines, steam boilers, and steam equipment during his work in the Navy. At the January 10 meeting, Ronald Ewen, an electrical engineering student at the University of Southern California, spoke on the various uses of electronic tubes. Mr. Ewen supplemented his talk with illustrations on an oscilloscope and several spectrum charts.

A field trip to the Thermador Electric and Manufacturing Company's plant was made on January 12. The group was shown the latest of Thermador's developments of machinery in the manufacturing of the 100 lb Navy practice bomb, Rador and radio transformers, 30 mm cartridge cases and electric heaters, and other outstanding machinery such as special uni-job seam welders, extrusion-cutting and metal-forming machines, and the very latest in commercial shearing machines.

On January 26 Robert Beck, student speaker, gave a technical report on electron lamps and electron discharge relative to photographic work as an employee of Amos Carr Studios. Following the meeting the members attended the volley-ball game held the same day with the A.I.Ch.E. branch playing against the A.S.M.E. Branch.

Stevens Institute of Technology Branch

A business and social meeting was held in Jacobus Hall on December 20 by the Branch, when a technical motion picture "Empires of Steel" was shown. This dealt with the construction of the Empire State building, and covered construction from the iron ore in the mines to the smelting and refining, then to the steel columns, and finally to the finished building. Diagrammatic sketches indicated the progress of construction. Chairman Dankerbring then held a brief discussion on the program for 1945 as outlined by the Program Committee. At the conclusion of the business discussion three humorous motion pictures were shown.



UNIVERSITY OF TORONTO BRANCH OFFICERS

(*Front row, left to right:* D. M. Alloway, papers and meetings secretary; A. R. Hamilton, chairman; Prof. I. W. Smith, honorary chairman; D. Elves, vice-chairman; G. W. Frey, secretary-treasurer. *Back row, left to right:* G. C. Campbell, 2nd year representative; R. E. Kinsinger, 4th year representative; E. Dalrymple, 3rd year representative.)

University of Texas Branch

At the meeting on January 8 in the Engineering Building the Branch entertained as their guests the student branches of the Institute of Aeronautical Sciences and the A.I.E.E. Paul Sidler, American representative of Brown, Boveri & Company, Zurich, Switzerland, was the speaker. He gave a very interesting talk on gas turbines, and after a question period Mr. Sidler courteously autographed copies of his article "A Gas-Turbine Road Locomotive" which appeared in November, 1944, MECHANICAL ENGINEERING.

Tufts College Branch

On January 3 at Robinson Hall, brief talks were heard by members on various aspects of engineering, in a contest sponsored by the Branch. First prize was won by Sumner Myers with his paper on "Visual Aids in Engineering Education." The winner will receive a prize from the local section and will represent the Section at the Sectional meeting to be held later in the month at Massachusetts Institute of Technology. Second place was won by William M. Dowden with a paper on "Roadable Aircraft or the Airmobile." The other winners were William L. Ramer, "Heating by Solar Radiation;" Jacob Wisnik, "Modern Methods of Electroplating;" John C. Pevear, "Chamber Throats;" Julian P. Mulak, "Farm Power;" and Robert L. Lauer, "Vibration in Turbine Wheels."

The latest in a series of films supplied by Lt. (s.g.) Bortolazzo of the First Naval District Training Aids Division was presented in the USNROTC classroom on Jan. 8. This film, entitled "Detonation," gave through animation the causes of detonation in internal-combustion engines and demonstrated the methods of prevention such as composition of the fuels, temperature of jackets, injection of water spray, mixture ratio, design of the combustion chamber. The film was interspersed with photographs of equipment, the effects of detonation and the preventive measures that could be taken.

At the Engineers Club in Boston on Jan. 9 a group of members from the Branch heard Dr. Sanford A. Moss of the General Electric Company talk on gas turbines. Dr. Moss traced the development of the gas turbine from his undergraduate days at Cornell through the last war, up Pike's Peak, and on to the Turbo-supercharger of the present day. In the question period that followed, Dr. Moss cleared up many questions of development and broad details of the subject.

The January 22 meeting at Robinson Hall featured a film entitled "Fireroom Practice," a movie usually presented in Midshipmen's School. The subject covered "lifting off" of new boilers and illustrated the accepted practice for getting up steam in boilers that have been shut down.

Thirty-seven members of the Branch attended the joint Tufts-M.I.T. meeting on January 28 at M.I.T. Two students of the Tufts Branch, William M. Douden and Sumner Myers, presented papers, after which a tour was made through the M.I.T. laboratories, where a CFR engine with high-speed indicator and a 250-hp triple-expansion steam engine were in operation.

University of Wisconsin Branch

W. I. Senger of the Gisholt Machine Company, Madison, Wis., was the featured speaker at the January 23 meeting of the Branch held at Wisconsin Memorial Union. Mr. Senger, who is an authority on balancing machines, gave a most interesting talk on that subject. He explained the theory of static and dynamic balancing with the assistance of sketches, showed how this theory was applied to the balancing machines, explained the working of the machines, and showed a number of special-purpose balancing machines.

Yale Branch

Three meetings in December were held at New Haven, Conn., by the Branch, featuring

papers by members. At the Dec. 5 meeting the papers were "A Musical Career" by G. P. Anastasion; "The Mining of Copper," by J. M. McFarland; "Glider's Part in the War," by J. D. Ross; "Salvage Operations on the Oklahoma," by A. Tankle; and "Greyhound Corporation," by Frederick Voos. On Dec. 12 the students heard papers by W. V. Braithwaite, "A Dark Room;" R. L. Koblenzer, "Crisis in China;" and G. W. Shaw, "Soap Box Derby." The Dec. 19 meeting featured "Alaska" by J. B. Dunn; "Bu Ships" (Bureau of Ships), by L. E. Hershey, and "Postwar Electronics," by E. Mioduszewski.

Similar programs were held on Jan. 2 and 9; at the former meeting, R. P. Carroll presented "The Worm Turns," a talk on the present Japanese position; R. Martin spoke on "Sea Power," and H. Schindleman gave a paper on "Further Notes on Airfoils." At the latter meeting the following papers were given: "Survival," by A. Tankle; "Snowflakes," by R. H. Bernstein; "Letter Writing," by S. Lampert; and "Carriers and Planes of the U. S. Navy," by W. Plamondon.

Another meeting was held on Jan. 17 when papers were presented by A. Ford, "Side Lights on the Olympic Games;" R. L. Koblenzer, "Blockade of Germany;" G. Szarkiewicz, "Commerce and Industry in Hong Kong;" C. A. Zabriski, "Power," a discussion of sources of energy in modern industry.

On January 23 the Branch heard papers by T. H. Burbank, "The Artificial Harbor;" J. B. Dunn, "Future Defense of the United States;" F. D Miller, "Quality in Production;" I. D. Ross, "Crime and a Camera;" and G. R. Sergeant, "Cold Starting Fuels for Diesel Engines."

Papers were presented at the January 30 meeting by F. W. Voos, "Business at War;" L. E. Hershey, "Armament of the B-29;" and M. Whiting, "National Yale Alumni Placement Service."

Awards for Student Papers

TWO annual awards totaling $700 for engineering-student papers of outstanding merit dealing with gray-iron research on designated subjects have been established by the technical committee of the Gray Iron Founders' Society, Cleveland, Ohio.

The awards, open to all graduate and undergraduate students in engineering and technology and expected to continue indefinitely, consist of a first prize of $500 and a second prize of $200.

Topics designated for investigation and study in the 1945 competition, which closes August 5, are creep values of gray irons at 600–800 F, elongation, impact values, machinability. The material for investigation of any phase of these subjects may be plain or alloyed gray irons or any group of gray irons.

All data presented should be comparable whenever possible, the committee has ruled, with data on like properties of other engineering materials.

Four judges will select the winners and the prizes will be presented at the annual fall meeting of the society or not later than October 31.

Judges in the 1945 competition are Norman F. Hindle of the American Foundrymen's Association, Dr. E. E. Marbaker, of the Mellon Institute of Industrial Research, and Donald J. Reese and Fred J. Walls of the International Nickel Company, Inc.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Boston, Mass.	Chicago	Detroit	San Francisco
8 West 40th St.	4 Park St.	211 West Wacker Drive	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

PLANT MANAGER-SUPERINTENDENT. Seasoned executive; aggressive, tactful, personality, broad experience manufacturing. Thorough knowledge plant layouts for mass production. Capable directing personnel training program; analyzing bottlenecks; assuming leadership, management production conferences. Me-887.

NATIONALLY CERTIFIED MECHANICAL ENGINEER of definitely proved executive, engineering, and business ability desires position general manager or territorial representative, will locate to suit right connection. Age 41. Me-888.

MECHANICAL ENGINEER, member Tau Beta Pi, desires responsible position. Eight years' heat-engineering experience in power plant and process design and betterment work. Capable of executive position. Me-889.

MECHANICAL ENGINEER, 65. To further war effort, available for consultation on mechanical engineering of essential mining, milling, smelting, or related prospects. Me-890.

CHEMICAL ENGINEER, twenty years' broad experience process development; plant design and construction, and general supervision engineering projects. Accustomed to cooperate with plant executives and get things done. Member A.S.M.E., A.I.Ch.E. Me-891.

MECHANICAL ENGINEER, graduate, 31, married; ten years' experience in adapting products to processes and industrial applications, involving engineering service, conducting educational meetings for plant personnel, desires position with postwar future. Me-892.

GRADUATE MECHANICAL ENGINEER, development, design—plastics, proved accomplishments this field. Excellent chemical background. Experienced setting up machinery, plant layout, organization, direction, analysis. Seeks permanent postwar connection with future. Me-893.

MANUFACTURING ENGINEER. Wide experience shop practice; preparation of drawings for production, processing, estimating, and tool design. Also, shop supervisory experience, familiar with tooling for high and low production. Age 42. Me-894.

MECHANICAL AND CHEMICAL ENGINEER, 45, registered professional, A.S.M.E., 23 years' broad experience chemical process, industrial, and metallurgical engineering, desires position director of development or chief engineer. Foreign languages. Will consider contracts abroad. Me-895.

MECHANICAL ENGINEER, excellent record of consulting, administrative, and university experience general engineering field, including research and development electro-mechanical devices, desires position chief engineer small, sound, mechanical manufacturing firm, preferably Philadelphia area. Willing to invest substantial sum. Me-896.

POSITIONS AVAILABLE

ENGINEERS, with at least ten years' experience in design and development heavy machinery or similar experience, for research and development work both as to design and from industry study points of view. Permanent, excellent opportunity. Write complete details of experience and personal record. $4000–$6000 a year. Location, Pennsylvania. W-4637.

ENGINEERS. (*a*) Chief engineer, experienced layout man with technical education and background high-speed rotating machinery such as turbines, blowers, internal-combustion engines, $7000 a year. (*c*) Project engineers, mechanical with ten to fifteen years' experience on development new products in power equipment field, such as gas turbines and air compressors. $6000 a year. Location, Pennsylvania. W-4896.

DIRECTOR OF ENGINEERING, not over 50, mechanical graduate, mechanical, electrical, and internal-combustion engineering experience, to direct engineering department well-known corporation in design, model construction, and testing farm tractors and implements. Should have about twenty years' experience in engineering, testing, and design of machinery and small multicylinder internal-combustion engines and knowledge of modern machine-tool practices. Must have execu-

[1] All men listed hold some form of A.S.M.E. membership.

tive ability. Salary open. Location, Middle-West. W-4897D.

ENGINEERS. (*a*) Designer, 32–45, mechanical graduate or equivalent, with three or four years' experience aircraft gun turrets. Experience in automotive, small tools, or precision equipment engineering. Aeronautical experience an advantage. Good knowledge of hydraulics and general mechanical engineering; capable of taking charge of a design section for development work on gun turrets and similar devices. About $9000. (*b*) Project engineers, 32–45, mechanical graduates or equivalent, supervise layout gun turrets and similar devices. Two years' experience gun mounts, turrets, or fire-control equipment required. Automotive, mechanical, or electrical engineering experience desirable. About $8400. Location, New England. W-4915.

DIRECTOR OF SAFETY, shipyard, 7500 employees. Should be qualified to handle meetings of managers and plant superintendents and have sufficient knowledge safety engineering to gain confidence and respect of supervisors and safety-department personnel. About $4000. Location, Connecticut. W-4921.

GENERAL SUPERINTENDENT, 40–50, take charge operations in several plants of old-established concern in light-gun and miscellaneous fields. Must have excellent background machine shop and assembly supervision. $10,000–$12,000 a year. Location, Connecticut. W-4927B.

INDUSTRIAL RELATIONS DIRECTOR for company employing 500 in metal trades. Must have had some experience in labor relations. $5000–$6000 a year. Location, Massachusetts. W-4941.

SUPERINTENDENT OF MANUFACTURING OR WORKS MANAGER, take full responsibility for company manufacturing fans, motors, and air-conditioning accessories. Plant employs 1500 doing war work. Permanent. $9000–$12,000 a year. Location, upper New York State. W-4948.

ENGINEERS. (*a*) Machine designer, 30–40, development textile machinery. Should have had machine-development experience on existing and new machines and be capable of supervising designers and draftsmen. Salary open. (*b*) Assistant plant engineer, 30–40, mechanical graduate preferred, with executive ability. Should have had experience in plant engineering and maintenance and be familiar with power-plant and machine-shop operation. $5000–$6000 a year. Location, Massachusetts. W-4953.

ENGINEERS. (*a*) Mechanical engineer to head department of mechanical research on household appliances. $6000–$10,000 a year. (*b*) Mechanical engineer to head department to develop complicated machinery. Salary, $6000–$10,000. (*c*) Mechanical engineer for research on combustion in coal-fired steam locomotives. $4200–$6000 a year. Location, Ohio. W-4955D.

CHIEF ENGINEER, mechanical graduate. Must have had considerable experience plate-fabrication plant. Will be in charge plate fabrication and unfired pressure vessels. Must understand all types of welding and proper application of stainless steel. $6000 a year. Location, Connecticut. W-4964.

DIRECTOR OF ENGINEERING, to 45, knowledge structural and mechanical engineering. Must be good administrator with experience in building large plants, preferably in oil or rubber industries, for a large chemical company. Will have the superintendent of construction and chief engineer under his supervision. Will be given an opportunity of six months to a year to study and report on the company's plants before starting actual operations on the company's properties. Permanent. $20,000 a year. Headquarters, East. W-4977—R-2457C.

ASSISTANT PLANT ENGINEERS, 35–50, graduates or equivalent, maintenance experience, to understudy and assistant plant engineers large chemical manufacturing plants. Must be able to get along with and handle men. Wartime positions. $6000 a year. Location, South and West. W-4989.

ASSISTANT TO CHIEF ENGINEER for company manufacturing foundry equipment. Must have had experience foundry practices and procedures. Will be responsible for design, detail, and co-ordination of parts. $8000–$10,000 a year. Location, Ohio. W-5008D.

SALES ENGINEER, 40–50, mechanical graduate, with hydraulic and wide mechanical equipment experience, to be technical representative of manufacturer. $10,000–$12,000 a year. Headquarters, Toronto, Canada. W-5020.

CHIEF ENGINEER, 40–50, graduate, good administrator, familiar with metal manufacturing processes and methods. Experience in design for low-cost production. Should have held similar position as chief engineer with minimum of five years' experience in executive capacity. Salary open. Location, Washington, D. C. W-5033.

A.S.M.E. Local Sections

Coming Meetings

Anthracite-Lehigh Valley: March 23. Meeting to be held at Hamburg, Pa., at 8:00 p.m. Subject: "The Hydraulic Handling of Material," by Frank B. Allen, president of the Allen-Sherman Hoff Co. This paper is to be followed by inspection of working examples of hydraulic material handling equipment.

Birmingham: March 14. Tutwiler Hotel at 8:00 p.m. A talk on "Gas Turbines" by some outstanding speaker on this subject and movies loaned by the Allis-Chalmers Company.

Boston: March 15. Northeastern University, Boston, Mass. at 8:00 p.m. Subject: "Centrifugal Casting," by Nathan Janco, The Centrifugal Casting Machine Co., Tulsa, Okla.

Central Illinois: March 8. Jefferson Hotel, Peoria, Ill. Subject: "Bell Aircraft Helicopter," by Bartram Kelley, assistant director, Helicopter Division, Bell Aircraft Corporation, Buffalo, N. Y.

Central Indiana: Antlers Hotel, Indianapolis, at 8:00 p.m. Subject: "Engineering in Foreign Countries," by George E. Hines, consulting engineer, Russell B. Moore Co.

Cleveland: March 8. Cleveland Engineering Society Rooms, Cleveland, Ohio, at 8:00 p.m. Subject: "High-Pressures, High-Temperature Steam Generators," by Otto de Lorenzi, director of education, Combustion Engineering Corp., New York, N. Y.

Detroit: March 6. Engineering Society of Detroit Building, Detroit, Mich. Dinner at 6:30 p.m. Meeting at 8:00 p.m. Subject: "The Elements of Simplicity in the Design of Power Plants," by George C. Daniels, mechanical engineer for the Commonwealth and Southern Corp., New York, N. Y.

Louisville: March 15. Auditorium of Speed Scientific School, University of Louisville, Louisville, Ky., at 8:00 p.m. Subject: "Some Practical Aspects of Automatic Control," by W. H. Steinkamp, Brown Instrument Co.

Mid-Continent: March 6. Oklahoma A. & M. College, Stillwater, Okla., at 8:00 p.m. Subject: "Practical Machinery Design," by D. O. Barrett, chief engineer, Gulf Oil Co., Tulsa, Okla., March 29. Mayo Hotel, Tulsa, Okla., at 8:00 p.m. Subject: "Electrical Precipitation as Applied to Fluid Catalyst Cracking Units," by some authority on the subject.

New Haven: March 14. Mason Laboratory, Yale University at 8:00 p.m. Subject: "Modern Railway Equipment," by J. M. Knight, research mechanical engineer, The American Car and Foundry Co.

Ontario: March 15. Joint Meeting with Toronto Branch, Engineering Institute of Canada. Subject: "Problems in Army Engineering," by R. E. Jamieson, director-general of Army Engineering, Department of Munitions and Supply, Ottawa.

Philadelphia: March 27. Philadelphia Engineers Club, 1317 Spruce St., Philadelphia, Pa. Subject: "Aircraft Industry in the Post-war Period," by J. F. Trippe, president, Pan American Airways, Inc., New York, N. Y.

Plainfield: March 21. Elks Club, Elizabeth, N. J., at 8:00 p.m. Subject: "Gas Turbines," by S. A. Tucker, McGraw-Hill Publishing Company, Inc., New York, N. Y.

Rochester: March 1. Hotel Sheraton, Rochester, N. Y., at 8:15 p.m. Panel discussion, A.I.E.E. and R.E.S. co-operating on the subject, "Adjustable Speed Driver for Industry." March 8. Subject: "New Developments in Modern Gearing," by Ernest Wildhaber, Gleason Works, Rochester, N. Y.

Rock River Valley: March 15. Madison, Wis. (Wooden Bowl), at 7:00 p.m. Subject: "Velox Boilers and Gas Turbines," by Paul R. Sidler, resident engineer, Brown, Boveri & Co., Ltd., Baden, Switzerland.

Washington, D. C.: March 8. Potomac Electric Power Co. Auditorium at 8:00 p.m. Subject: "Structural Development of the Modern Airplane," by Dr. John E. Younger, professor of aeronautics, University of Maryland, College Park, Md.

Providence: March 6. Providence Engineering Society Building at 8:00 p.m. Subject: "Gas Turbines," by C. Richard Soderberg, Massachusetts Institute of Technology, Cambridge, Mass.

A. P. M. Fleming Honored

AMONG the Knights Bachelor mentioned on the New Year's Honor List was the name of A. P. M. Fleming, member, director, Metropolitan-Vickers Electrical Company, Ltd., of Manchester, England.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after March 26, 1945, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ALLEN, SAMUEL G., New York, N. Y.
ALLWEIN, A. F., Mt. Airy, Philadelphia, Pa.
ANDERSON, JAMES L., Huntington Park, Calif. (Rt & T)
ARNOLD, GRAYSON BERT (ENSIGN), Los Angeles, Calif.
BANCHERO, JULIUS T., Ann Arbor, Mich.
BARRETTA, VAL S., Trenton, Mich.
BEYER, JOHN R., Baltimore, Md.
BILISOLY, CHARLES S., Alexandria, Va.
BIRD, FREDERICK J., Chicago, Ill. (Rt)
BLACKMON, H. N., Pittsburgh, Pa.
BOYD, JOSEPH J., Tulsa, Okla.
BRKICH, ALEXANDER, Phillipsburg, N. J.
BROSENE, W. G., JR., Cincinnati, Ohio
BROWNE, ALBERT A., Sunnyvale, Calif.
BRUNS, H. RICHARD, Staten Island, N. Y.
CAMPBELL, JOHN M., Detroit, Mich.
CARSWELL, JOHN STOKES, Caldwell, N. J.
CARTIN, S. F., Watertown, N. Y.
CHAPMAN, J. BARTON, Fairfield, Conn.
CHARLEWOOD, C. B., London, England
CHAUVIN, EMANUEL E., Toronto, Ontario, Can.
CRAWFORD, KENNETH Z., Douglaston, N. Y.
DANS, BERNARD D., Brooklyn, N. Y.
DAVIS, LINCOLN K., Brockton, Mass.
DE LORENZO, A. PAUL, Brooklyn, N. Y.
DIAMENT, WILLIAM A., Jenkintown, Pa.
DIBBLE, CLARENCE H., Hollywood, Calif.
DICKERMAN, W. C., JR., New York, N. Y.
DODGE, WILLIAM W., JR., Asheville, N. C.
DOUGHTY, CHARLES J., New York, N. Y.
DOUGLAS, MELVIN, Chicago, Ill.
DYCK, A. W., Winnipeg, Manitoba, Can.
EPPELSHEIMER, P. C., Atlanta, Ga.
FAVA, ALBERT A., Woburn, Mass.
FILES, CARL W., College Station, Texas (Re)
FLETCHER, T. F., La Plata, Argentina
FORBES, W. G., Bayside, N. Y. (Rt)
FORHECZ, JOSEPH A., Passaic, N. J.
GASTON, CHARLES M., New York, N. Y.
GEIST, JAMES WM., Pittsburgh, Pa.
GESSOW, IRVING D., Brooklyn, N. Y.
GIBBS, L. T., Tulsa, Okla.
GOODISON, LOUIS E., Kansas City, Mo.
GREGORY, J. J., Creighton, Pa.
GULBALIS, T. A., Tripoli, Lebanon
HAACK, DONALD J., Akron, Ohio
HALBFASS, ARNOLD J., New York, N. Y. (Rt)
HARMS, CARL F., Greensburg, Pa.
HARRIS, HERBERT I., Flushing, N. Y. (Rt & T)
HART, JOHN S., W. Lafayette, Ind.
HILL, ERLE G., Wheeling, W. Va.
HIRSCH, EDWARD F., JR. (ENSIGN), New York, N. Y.
HOEY, S. C., Wilkinsburg, Pa.
HOFFMANN, ALEX F., London, England
HOSTLER, NORMAN RUSSELL, New York, N. Y.
JANES, ANDREW M., Livingston, N. J.
JENSEN, WALTER E., Elgin, Ill.
JOHNSON, JEROME A., New York, N. Y.
KISH, GEORGE D., Bradford, Pa.
KOCH, WILLIAM M., Houston, Texas
KOCYAN, GEORGE H., Philadelphia, Pa.
KOVACS, STEPHEN F., Cleveland, Ohio
KRUEGER, JOHN W., Dayton, Ohio (Rt & T)
LANNER, ARNE, Kansas City, Mo.
LA SALVIA, ANTHONY J., Phoenix, Arizona
LAZIER, MORLEY J. C., Toronto, Ontario, Can.
LEDEEN, HOWARD L. (LIEUT.), Lansing, Mich.
LEVITT, ALBERT P., Cambridge, Mass.
LILIENTHAL, FREDERICK C., Scotch Plains, N. J.
LINDER, CLARENCE H., Schenectady, N. Y.
LOMBARD, N. A., Glendale, Calif.
LOWEKE, GEORGE P., Detroit, Mich.
LYMAN, HUGH M., Great Neck, N. Y.
MADDOCK, BILL, Hermosa Beach, Calif.
MCEDWARDS, J. A., Birmingham, Ala.
MEHTA, M. D., Alipore, Calcutta, India
MERKINE, JACK, Tel-Aviv, Palestine
MONROY, H. R., Mexico City, Mexico
MOODIE, DAVID, New Orleans, La.
MULLEN, J. P., Washington, D. C. (Rt)
NELSON, ANDREW, Excelsior, Minn.
OAKEY, WILLIAM E., JR., Yellow Springs, Ohio
PAVLIK, W. J., Northport, N. Y.
PEACOCK, FRANK E., Wilmette, Ill.
PEARSON, JOHN S., Salt Lake City, Utah
PONKSHE, H. D., Ann Arbor, Mich.
PRINCE, DAVID C., JR., Marblehead, Mass.
PULLAR, W. R., Burwood, N. S. W., Australia
RAGSDALE, E. J. W., Norristown, Pa.
RANEY, RUSSELL R., Chicago, Ill.
RATCLIFFE, F. D., Tulsa, Okla.
RAWSON, R. H., Portland, Ore.
RICHARDSON, PERCY L., Whitestone, N. Y. (Rt & T)
ROBINSON, WILFORD J., Arlington, Va.
ROBSON, CHARLES J., Oakmont, Pa.
ROCKWELL, RALPH A., Boston, Mass.
ROSENBERGER, Albert J., Wilmette, Ill. (Rt & T)
RUSKIN, PHILIP, New York, N. Y.
SALO, ERIC A., Vestal, N. Y. (Rt & T)
SANTOS, ANIBAL, Teaneck, N. J. (Rt & T)
SCALISE, ANTHONY F., Springfield, Mass.
SCHMITZ, CARL EDWARD, Chicago, Ill.
SKOVE, THOMAS M., Cleveland, Ohio
SMALENBERGER, EDWARD ARNOLD, JR., Lancaster, Pa.
STEYSKAL, RAYMOND F., Hurley, N. M.
STROWE, CHARLES G., Charleston, W. Va.
SURINAK, J. J., Iron Mountain, Mich.
URAN, NEJDET F., Berkeley, Calif.
URQUHART, NOEL, Garden City, N. Y.
VYAS, C. S., Dalmianagar, Bihar, India
WALTER, D. E. (LIEUT. COMDR.), Seattle, Wash.
WARE, D. H., Schenectady, N. Y.
WEBBER, G. C., Indianapolis, Ind.
WELLER, ARTHUR S., Oakland, Calif.
WELSH, FRANK H., Endicott, N. Y.
WHITE, JOHN E., Trenton, N. J.
WILLARD, DONALD E., Danville, Ill. (Rt)
WOYNAR, BASIL, East Chicago, Ind.
WULF, H. E. J., Detroit, Mich.
WULFINGHOFF, MAX F. A., Fort Thomas, Ky.
YOUNG, EDGAR WAYNE, Los Angeles, Calif.
ZAHKA, ANTHONY G., Jersey City, N. J.

CHANGE OF GRADING

Transfers to Member

BURCH, KENYON C., Los Angeles, Calif.
BUTCHER, JOSEPH H. (LIEUT.), Los Angeles, Calif.
CAFIERO, DOMINICK, Drexel Hill, Pa.
CAMPBELL, JESSE M., East Lansing, Mich.
CLAESSENS, FRANK A., Brooklyn, N. Y.
ELSWORTH, JOHN VAN V., Watertown, N. Y.
FORBES, F. POWELL, Newark, N. J.
FREUND, H. E., Meadville, Pa.
HEUSER, FRED, Gasport, N. Y.
HOLDING, J. BREWSTER, Columbus, Ohio
HUTCHINS, W. E., Newark, N. J.
MORROW, J. GORDON, Port Washington, N. Y.
SHULL, DONALD W., Hamilton, Ohio
SWENGEL, F. M., Avondale, Arizona

Transfers from Student-Member to Junior—63

A.S.M.E. Transactions for February, 1945

THE February, 1945, issue of the Transactions of the A.S.M.E. contains:

The Missing Data on Coal Sampling, by B. A. Landry

Electrical-Analogy Method for Fundamental Investigations in Automatic Control, by D. P. Eckman and W. H. Wannamaker

Stabilizing a Suction-Relief Valve, by Ed S. Smith

Economic Thickness of Thermal Insulation for Intermittent Operation, by C. B. Bradley, C. E. Ernst, and V. Paschkis

Shear Strength of Glue Joints as Affected by Wood Surfaces and Pressures, by J. W. Maxwell

New Machines for Creep and Creep-Rupture Tests, by M. J. Manjoine

Some Thermal Effects in Oil-Ring Journal Bearings, by R. A. Baudry

Effect of Aeration on Gear-Pump Delivery and Lubrication Ceiling, by P. H. Schweitzer

Boiler Nozzles and Valve Inlets for Maximum Capacity Safety Valves, by E. K. Falls

Necrology

THE deaths of the following members have recently been reported to headquarters:

DALLAS, JOHN, March 5, 1944
DODGE, GORDON F., December 25, 1944
GREGORY, WILLIAM B., January 30, 1945
HARRIS, WILLIAM A., November 18, 1944
JONES, WILLIAM A., January 31, 1945
PERRY, HAROLD S., November 3, 1943
STROUSE, SIDNEY B., January 23, 1945
TAUBE, HARRY R., January 10, 1945
TIERNEY, JOHN P., January 13, 1945

• Keep Informed . . .

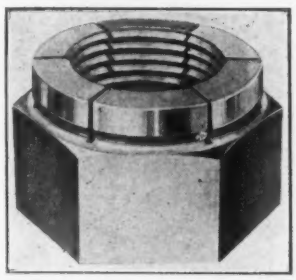
Announcements in this section are supplied by current advertisers in MECHANICAL ENGINEERING and A.S.M.E. MECHANICAL CATALOG. This section is restricted to these advertisers.

• *NEW EQUIPMENT*
• *BUSINESS CHANGES*
• *LATEST CATALOGS*

Available literature may be secured by addressing a request to the Advertising Department of MECHANICAL ENGINEERING or by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• NEW EQUIPMENT

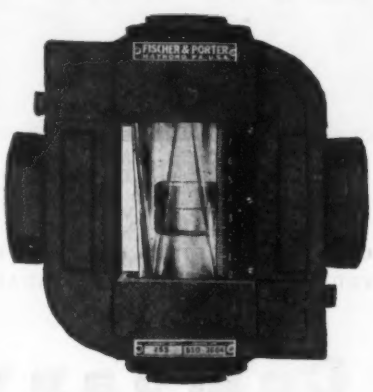
Self-Locking Nut



Featuring one-piece construction, Flexloc stop and lock nuts resist backing off when seated and are practically vibrationproof. Top has six radial slots as shown, providing equal number of sections which perform locking action. These sections are flexible and adapt themselves to wide range of tolerance without affecting torque. Locking action is unaffected by temperatures as high as 750 degrees Fahr. Each thread in slotted section carries its portion of load. Nut is available in commercial metals such as steel, aluminum, bronze and brass. Sizes are available in National Coarse thread from 6-32 to 1-8 and in National Fine thread from 6-40 to 1-14. Made by Standard Pressed Steel Co., Jenkintown, Pa.

New Type of Flow Indicator

Fischer & Porter Co. announce their new Rotasight Flow Rate Indicator. This little instrument is rapidly replacing Bull's Eye Sight Flow Indicators because it indicates the true flow rate, even though it is very compact and comparatively inexpensive.

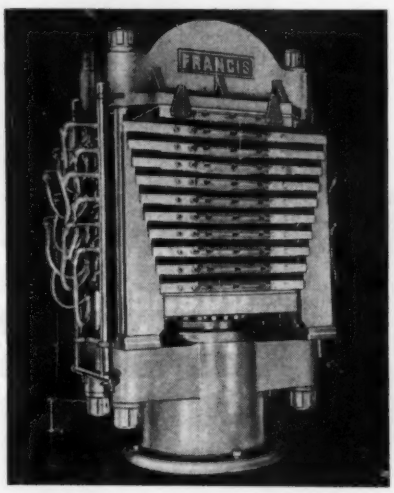


The Rotasight operates on the rotameter area-type principle and has a V-ported transparent metering tube with a float which rises in direct proportion to the flow through the meter. The catalog is profusely illustrated and describes construction details and applications of the instrument in a very clear manner. It also gives engineering dimensions, flow capacities and prices.

One of the most interesting applications described is the use of the Rotasight as a flow rate alarm. The manufacturer claims that it is the only alarm that is operated by flow rate changes only and which is equally sensitive at all points in its flow range because of its straight line calibrations. In writing, ask for Bulletin 92-C, Fischer & Porter Co., 97 County Line Road, Hatboro, Pa.

General Purpose Steam Plate Hydraulic Press

A very practical variation to a small general purpose hydraulic press is to be found in the recent announcement by the Chas. E. Francis Co. of Huntington, Indiana, of their Steam Plate Press. The one illustrated is a 30″ × 30″ × 2″, a 153-ton capacity hydraulic general purpose press with motor driven pump unit, automatic pressure and temperature controls, and is equipped with eleven steam plates. It is reported that this press can be furnished with 14″ or 16″ diameter cylinder, and with or without pumping unit.



Among features the manufacturer claims valuable to the user are: extremely husky plate support, "V's" for easy loading, and the fact that strain rod nuts have a special locking device to prevent unscrewing.

Although it is reported that this press was designed to handle laminated plastic for war items, it is also ideal for a wide variety of other plastic work, particularly for plastic playing cards or similar items.

For further information on this general purpose press, write the manufacturer.

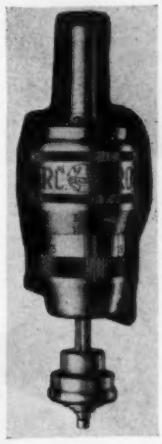
Mass Production of Aluminum Bridge Parts Made Possible by Lincoln Welding Process

A process of automatic carbon arc welding, which was perfected by The Lincoln Electric Co., Cleveland, Ohio, is said to be the only method by which vitally needed aluminum parts for military bridges can be fabricated on a mass scale.

The welding equipment used for this high production project is a Lincoln product known as the "Electronic Tornado." It is a process of shielded carbon arc welding which has already established itself as the standard procedure where volume output is called for in fabricating various industrial and war essentials such as tanks, boilers, piping, automotive parts and various machinery items.

Now, the process has been so successfully applied to the production of aluminum parts for special military bridge structures that 35 engineers representing 14 different firms from 9 states have been attending a special course on the application of the "Electronic Tornado" in the automatic welding of aluminum at the Lincoln plant. A study of manual shielded arc welding of this metal is also included in the course which is being conducted by Lincoln welding engineers and consultants.

New Waldes Grooving Tool



Frequently the precision boring of internal grooves for retaining rings or other purposes poses a knotty problem for engineers. Very often the operation requires much ingenuity and in many cases the operation demands skilled hands.

Waldes Koh-I-Noor, Inc., Long Island City 1, N. Y., has just issued a folder which shows and describes a new, patented device that answers the problem and can be used with any ordinary drill press, turret lathe or boring mill. What's more, unskilled labor, including women, can use it with speed and accuracy.

Di-Acro Radius Brake

O'Neil-Irwin Mfg. Co., Minneapolis 15, Minn., announces an entirely new product, known as the "Di-Acro" Radius Brake, which was designed and developed at the request of aircraft manufacturers who required a precision machine capable of properly forming duraluminum, chrome molybdenum, rust resistant and spring tempered alloys, and various other low ductile materials essential in the fabrication and production of aircraft.

This precision Radius Brake entirely eliminates the possibility of fracture or disintegration developing at the line of forming, while working such materials.

The radii obtainable with this unit are in accordance with the predetermined standards recommended by the United States Army Air Corps for aircraft construction.

Case hardened and spring tempered materials that must be formed after heat treat-

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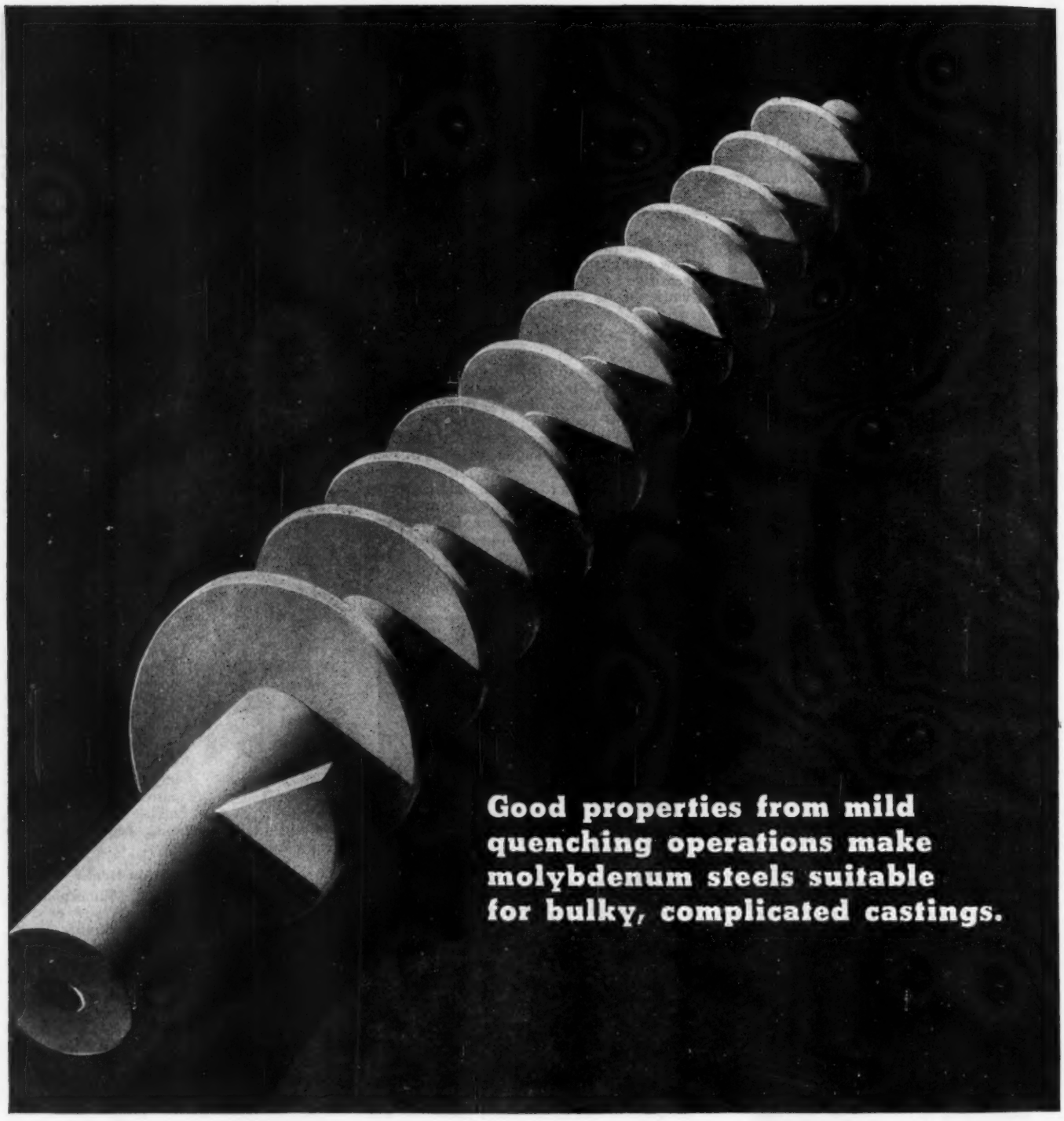

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

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• Keep Informed

ing can also be safely and economically worked to accurate dimensions with the "Di-Acro" Radius Brake.

The extreme flexibility built into each "Di-Acro" Radius Brake makes it an ideal unit for testing and determining ductile qualities of a wide variety of alloys and substances. It is adaptable for an almost unlimited range of laboratory and experimental research work, preparatory to selecting proper materials and developing the design of experimental or finished working models.

The latest edition of the new 40-page "Di-Acro" Catalog, which carries complete information covering this new machine is available to readers upon request.

Ashcroft Announce New Air Control

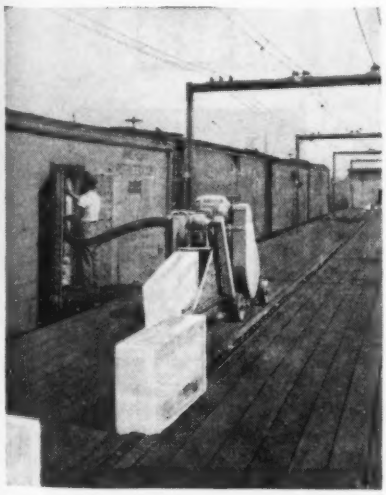
The announcement of a new simple, rugged durable, dependable air control for shallow well pumps is made by Manning, Maxwell & Moore, Inc., Bridgeport, Conn.

In placing this new Ashcroft Air Control on the market, the manufacturer announces many features exclusively Ashcroft. They include rubber diaphragm as the one single moving part which combines valve head, gland seal, and float hinge. The Valve has stainless steel orifice and is completely sealed. It has no water cavities. Body is either Cast Brass or Cast Iron. Unit is compact, light weight, measuring $1\frac{3}{4}$" between wrench flats. Control is for applications up to 80 lb. PSI tank pressure.

An illustrated descriptive folder giving all details as to application, etc., will be furnished to any one writing the Electro-Mechanical Division at Bridgeport, Conn.

New Link-Belt High Capacity

A Model 440 Ice Crusher-Slinger is announced by Link-Belt Co., Chicago and San Francisco, as the newest addition to the company's line of ice crusher-slingers for top-icing of shipments of green vegetables, fish and other perishable produce.

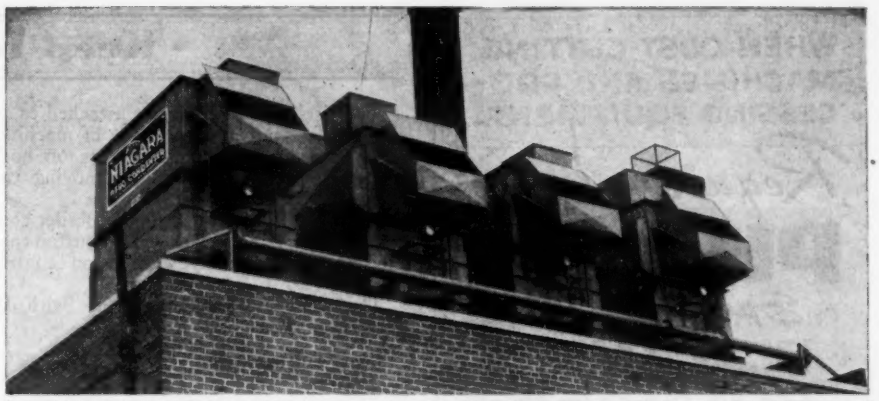


The new "440" unit is a large capacity, portable machine for heavy-duty service, capable of crushing six 300-lb. cakes of ice in 90 seconds and slinging the resulting "snow-ice" into refrigerator car through a flexible discharge hose held and directed by the operator.

The machine has a low hinged ramp and a chain type feeder with pushers that take hold of the cake of ice and automatically feed it into the crusher No lifting of cake is necessary.

The crusher and all working parts of the machine are enclosed.

Continued on Page 30



NIAGARA
Evaporative COOLING
Does It Better

Cooling Fluids with Closer Control of Temperature

Niagara Aero Heat Exchanger cools liquids or gases to within 10° of atmospheric wet bulb temperature and holds them to a tolerance of 2°F. with the NIAGARA "Balanced Wet Bulb" control.

"BALANCED WET BULB"
TEMPERATURE CONTROL

U. S. Patent Re-issue No. 22,533
U. S. Patents 2,166,397; 2,296,946;
Re-issue No. 22,553
Other Patents Pending.

Holding Temperatures of Quenching Baths

Hundreds of heat treaters now use Niagara Aero Heat Exchanger to cool and control quenching baths, improving quality, increasing production, avoiding troubles, and saving cooling water expense.

Compressed Air After-Cooling

Niagara Aero After Cooler cools compressed air colder to eliminate one-half the moisture permitted by conventional methods and controls jacket water temperature. Saves cooling water cost.

Condensing Refrigerant Gases

Niagara Duo Pass Aero Condenser saves power, increases compressor capacity, saves condensing water cost, increases plant production. Duo Pass prevents scale formation; assures full capacity always.

OTHER USES OF NIAGARA AERO HEAT EXCHANGERS include chemical and industrial process liquid cooling, engine jacket water cooling, hydraulic fluid cooling, transformer oil cooling, lubricating and cutting oil cooling, water jacketted bearing and furnace cooling, vapor and steam condensing.

Consult your Niagara Engineer for information on any application of air engineering equipment, including air conditioning for industrial processes, NIAGARA "No-Frost" refrigerating systems for storage or process, heating, cooling, drying or humidification.

NIAGARA BLOWER COMPANY

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Field Engineering Offices in Principal Cities

INDUSTRIAL COOLING HEATING • DRYING
NIAGARA
HUMIDIFYING • AIR ENGINEERING EQUIPMENT

WHEN COST-CUTTING MACHINES AND PROCESSING EQUIPMENT—

Require

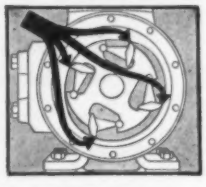
PUMPS

Specify

BLACKMER ROTARIES

SELF-ADJUSTING FOR WEAR

Wear is confined to these points... the tips of the buckets.



"BUCKET DESIGN"

swinging vanes automatically compensate for wear. When the "buckets" finally wear out, a simple replacement job restores the pump to normal capacity.

Write for Bulletin No. 306 — Facts About Rotary Pumps

BLACKMER PUMP COMPANY

1920 Century Avenue Grand Rapids 9, Mich.

BLACKMER Rotary PUMPS
BUCKET DESIGN—SELF-ADJUSTING FOR WEAR

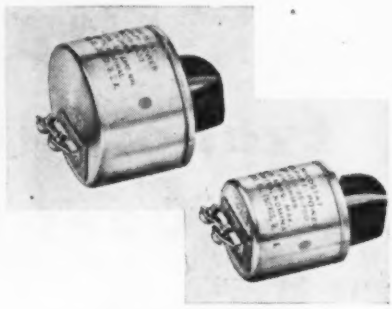
• Keep Informed . . .

The discharge hose may be attached to an adjustable spout at either side of machine, thus permitting the icing of cars on both sides of island docks without moving the machine.

Separate motors operate the feeder-conveyor, crusher and slinger. Push-button controls are conveniently located on control panel.

The machine is available for use with direct current and 2 or 3 phase A. C.

New Ohmite Army-Navy Aircraft Rheostats



Two new approved Power Rheostats for aircraft are announced by The Ohmite Manufacturing Co., Chicago. These new units are made in accordance with the latest Army-Navy Aeronautical Specifications AN-R-14a. (Drawing 3155.) They have many well-known Ohmite Rheostat features plus new, improved control protection. They are rugged in design and construction to provide uniform electrical and mechanical control, and utmost dependability, under all operating conditions of heat, cold, humidity, altitude, shock and vibration.

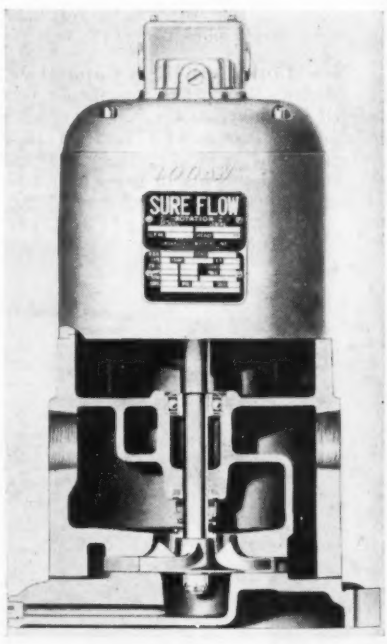
These new approved Ohmite AN Aircraft Rheostats are light in weight—lighter than the allowable weight specified. They meet the salt spray corrosion test, and other critical tests—and operate satisfactorily in the temperature range from −55°C (−67°F) to +70°C (+158°F).

Two sizes: Ohmite Model "J" 50-watt and Model "H" 25-watt. Linear or Taper wire-wound, in various resistances, with "off" position, as required. Totally enclosed in a compact, corrosion-resisting metal container. Complete with knob as shown.

For further information, write to the Ohmite Manufacturing Co., 4835 Flournoy St., Chicago 44, Ill.

"Logan" Sure-Flow Pumps

An improved line of Centrifugal Pumps, including 27 different sizes and types and designated as "Logan" Sure-Flow Pumps, is announced by Logansport Machine Co., Inc., of Logansport, Indiana. Although the "Logan" Pumps are designed especially for pumping coolants and cutting oils, they are adaptable for circulating cooling liquids, pumping or circulating water or quenching oil and general liquid transfer service. Foot Mounted, Bracket Mounted, Flange Mounted, Grinder and Submerged types are available.

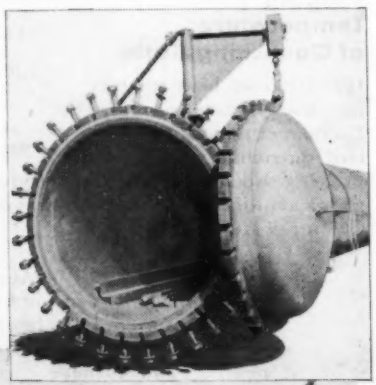


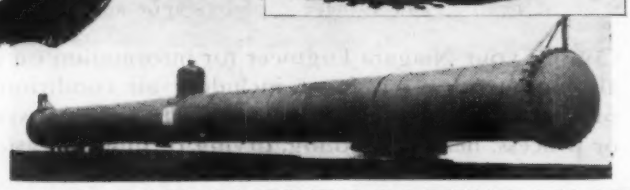
One of the features of "Logan" Sure-Flow Pumps, which guarantees maximum pumping efficiency, is the open impeller. It eliminates the need for close clearances or metal-to-metal contact of running parts and, thus, allows pumping of liquids containing some abrasives, filings and other foreign matter without damage to the pump.

"Logan" Pumps are equipped with integral motor drive, which allows greater latitude in locating the pump, since no gears, chains or other forms of mechanical drive are necessary. Thus, there are no vibrations set up, which might be transmitted through the frame and spindle to the work and prove detrimental, particularly on grinding, honing or other precision operations.

Self-priming without submerging, a noteworthy feature of the base and bracket

for vital COMMUNICATION TRANSPORTATION and SHIPPING *needs*





DOWNINGTON-BUILT CREOSOTING TANK

. . . PRESERVES MATERIALS FOR ARTERIES OF TRADE

Three flat cars were required to transport this 130' unit from the Downingtown Iron Works to the plant of the Keystone Wood Preserving Company, Eddington, Pa. 72" inside diameter, equipped with heating coils, special track and guide rails, fitted with swing-type doors operated on overhead davits, this cylinder is used for creosoting telegraph and telephone poles, railroad ties, lumber and piling for docks and wharves.

Poles, ties, lumber and piling are loaded on small tram cars and rolled into the cylinder where treatment is applied at various pressures up to 200 lbs. p.s.i. with a 2" to 4" penetration.

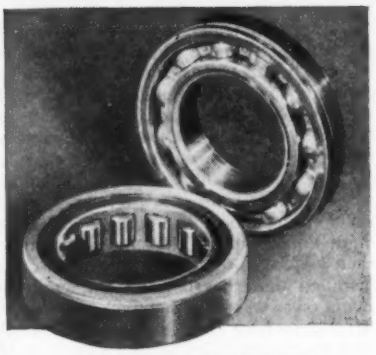
Downingtown's specialized knowledge has been applied to the design and fabrication of large, difficult and otherwise out of the ordinary jobs for various industries. Thirty consecutive years' experience . . . adequate, modern facilities . . . built-in quality . . . careful selection of materials, plus rugged construction . . . the consultation of a nationally known metallurgical authority . . . all add up to the complete satisfaction of the customers.

Send for the "Fabrication Book." Engineering consultation welcomed.

Our Heat Transfer Equipment bulletin on the design and fabrication of heat exchangers will be mailed on request. Ask for it on your letterhead, please.

DOWNINGTOWN IRON WORKS
DOWNINGTOWN, PA.
WELDED and RIVETED PRODUCTS

BALL BEARING LUBRIPLATE



FOR ALL TYPES OF ANTI-FRICTION BEARINGS

BALL BEARING LUBRIPLATE is a single grease type lubricant developed for general use on roller, ball and plain sleeve bearings operating at speeds up to 5000 RPM and at temperatures up to 300° F. Its performance is outstanding. BALL BEARING LUBRIPLATE not only does a better lubrication job, but it definitely gives protection against the arch enemy of bearings . . . corrosion. Increase the life of your bearings with LUBRIPLATE.

LUBRIPLATE

Lubricants definitely reduce friction and wear to a minimum. They lower power costs and prolong the life of equipment to an infinitely greater degree. LUBRIPLATE arrests progressive wear.

LUBRIPLATE

Lubricants protect machine parts against the destructive action of rust and corrosion. This feature alone puts LUBRIPLATE far out in front of conventional lubricants.

LUBRIPLATE

Lubricants are extremely economical for reason that they possess very long life and "stay-put" properties. A little LUBRIPLATE goes a long way.

Write for a booklet, "The LUBRIPLATE Film", written especially for your industry.

LUBRIPLATE
FISKE BROTHERS REFINING CO.
NEWARK 5, N. J.
TOLEDO 3, OHIO
OUR 75TH YEAR
1870 - 1945
DEALERS FROM COAST TO COAST

• Keep Informed

mounted models, affords extreme latitude in locating the pump in relation to the liquid to be pumped. These two models can be installed at any convenient point above, below or remote from the liquid. Self-priming without submerging is readily accomplished without resorting to the use of auxiliary priming reservoirs, check valves or any other accessory equipment.

The totally enclosed ball-bearing type of motor used for motivating "Logan" Sure-Flow Pumps is completely protected against splashing liquids, abrasive dust and other harmful foreign elements. Since the maximum power is consumed at zero pressure, "Logan" Pumps cannot be overloaded and any increase in static head, friction head or back pressure reduces delivery and power requirements. Each motor size is carefully selected to assure ample power for continuous operation at maximum pump capacity.

The base, bracket and flange mounted models employ an improved rotary seal for protecting the motor and bearings from the liquid. This seal, which effectively prevents the entry of air into the suction side of the self-priming models, is self-adjusting, easily accessible for servicing and is never subjected to the full pumping pressure. Grinder and submerged models have no seals, an overflow hole in the top of the column prevents liquid within the pump from reaching the motor bearings.

Rabbeted mounting of the motor housing of "Logan" pumps assures permanent alignment of pump and motor. The pump drive is direct through a single vertical shaft, which runs in grease packed ball bearings. A simple and compact assembly results from the mounting of the impeller on the extended motor shaft. "Logan" Sure-Flow Pumps require a minimum of floor space because of their vertical construction.

Engine Builder, Effects Major Cupola Repair with Minimum Time Loss

One of the many instances where vital production schedules are maintained, despite unusual wear and tear on essential equipment, was exemplified recently at The Cooper-Bessemer Corporation's Mount Vernon, Ohio, foundry when the plant's cupola was repaired with the loss of only a single day's operation.

For some time it was realized by shop management of this 111-year old engine builder that their cupola was in urgent need of a new windbox section. The continual daily use of the cupola during the past few busy war years had left its signs of wear and repair was now necessary. The element of elapsed time was of paramount importance, because when the cupola is down there is no casting production. So, the project was placed in the lap of "Dave" Sanner, Metallurgist, with instructions to proceed with the task, with the least possible loss of working hours.

Continued on Page 32

LUBRIPLATE No. 205

MAKE ONE BEARING OUTLIVE TWO

LUBRIPLATE No. 205 is a lubricant developed for use in grease type anti-friction bearings operating at speeds from 5000 RPM to 20,000 RPM. Users of high speed machinery tell us that this remarkable lubricant often more than doubles the life of bearings. For the lubrication of anti-friction bearings with oil type housings LUBRIPLATE No. 1 or No. 2 is recommended depending upon the operating speed.

℞ FOR YOUR MACHINERY

No. 3—Ideal for general oil type lubrication. Ring oiled bearings, wick feeds, sight feeds and bottle oilers.

No. 8—Because of its high film strength and long life reflects outstanding performance in most types of enclosed gears (speed reducers).

No. 107—One of the most popular grease type products for general application by pressure gun or cups.

No. 70—For a wide range of grease applications, especially at temperatures above 200 degrees F.

No. 130-AA—Known nationwide as the superior lubricant for open gears, heavy duty bearings, wire rope, etc.

BALL BEARING—This is the LUBRIPLATE lubricant that has achieved wide acclaim for use in the general run of ball and roller bearings operating at speeds to 5000 RPM and temperatures up to 300 degrees F.

Write for a booklet, "The LUBRIPLATE Film", written especially for your industry.

LUBRIPLATE
FISKE BROTHERS REFINING CO.
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OUR 75TH YEAR
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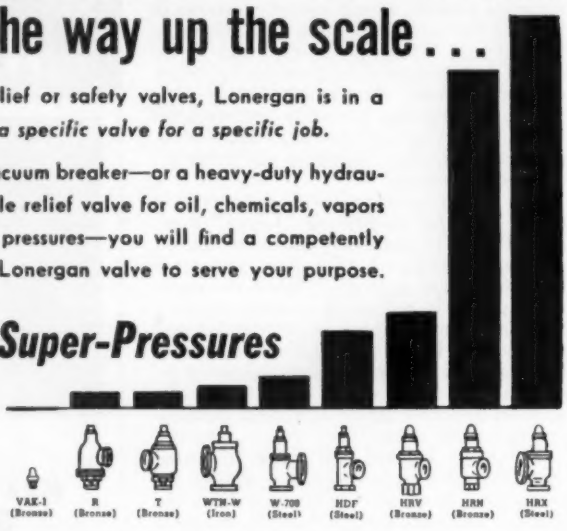
DEALERS FROM COAST TO COAST

LONERGAN Relief Valves Provide Pressure Protection all the way up the scale . . .

Whatever you need in relief or safety valves, Lonergan is in a position to serve you with *a specific valve for a specific job.*

Whether it is a simple vacuum breaker—or a heavy-duty hydraulic relief valve—or a nozzle relief valve for oil, chemicals, vapors at high temperatures and pressures—you will find a competently engineered, quality-built Lonergan valve to serve your purpose.

From Vacuum to Super-Pressures . . . and for Every Type of Pressure System



A valve to fill your requirements may be illustrated here. The list, of course, is only partial. In the complete Lonergan Line, you have one of the most comprehensive selections of safety and relief valve designs. Let us cooperate with you by submitting recommendations. For information, write—

J. E. LONERGAN COMPANY, 213 Race Street, Philadelphia 6, Pa.

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Pressure Gauges • Specialties

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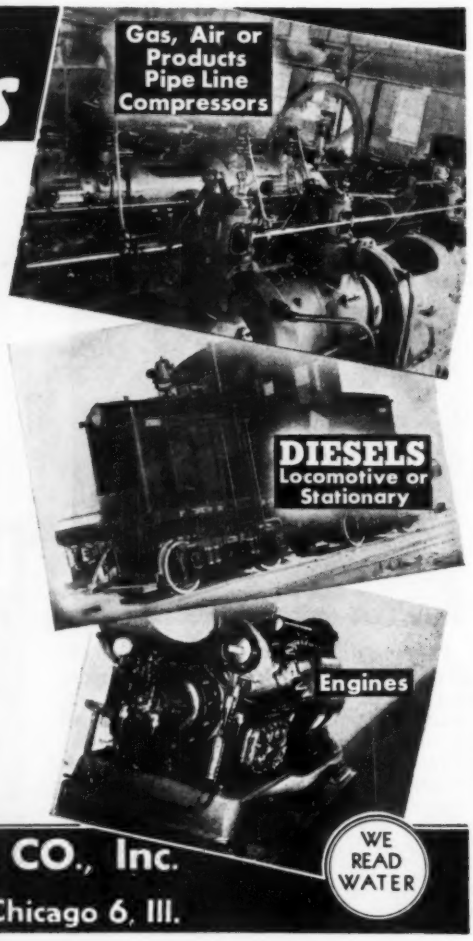


D. W. HAERING & CO., Inc.
GENERAL OFFICES
205 West Wacker Drive, Chicago 6, Ill.

WE READ WATER

• Keep Informed

Sanner enlisted the services of an erecting concern to assist him and plans were laid, preliminary work completed, necessary materials procured, and following a 53-ton pour one Friday afternoon, action started.

The old lining was removed during Friday night and shoring-up began early Saturday. Steel H beams were placed upright under the charging floor and wedged securely to hold the top part of the stack in place. A crane-hook was then attached to the bottom-ring to hold it in position while legs were removed.

After removal of the legs, the bottom-ring was cut loose from the windbox, lowered to the foundry floor, and dragged away by a main floor crane. The charging crane was then re-hooked to the old stack and cribbing installed underneath to guard against any swing or twist when the stack was cut loose. After detaching the old windbox it was lowered to greased rails and taken away by block and cable.

The new windbox was then slid under the charging floor by the same method, raised into position and held there by cribbing until partially welded. Following this the bottom ring was properly placed and all sections finish welded. During this operation the old sandstone foundation was cleared off and a heavy steel frame set on a foundation to level up.

The grouting was then poured using "High Early" strength cement in the mix. Legs were set and secured by bolts and welding. After covering the grouting for protection lining-up started while millwrights and electricians went ahead to complete their part of the work.

It was a big job to undertake and one which called for no interruption until completed. But due to the efficient before-hand preparations molten metal was run off a charge of 46 tons on Monday afternoon, with a loss of only one day's operation.

In addition to the production of heavy duty engines and foundry products at Mount Vernon, Ohio, Cooper-Bessemer's Grove City, Pa., plant has had a record year in the production of Diesel engines for military and industrial uses as well as cast tool shanks and forming tools for war production.

New Line of Steam Traps

Thermostatic steam traps have many well recognized advantages.

Since they work on the differential pressure between the inside and the outside of the bellows element, change in operating pressure does not necessitate change of valve seat. A given trap will work with equal efficiency at any pressure up to its maximum rating.

Due to the great lifting power of the thermostatic element, these traps have much larger valve orifices than can be provided on float or bucket types. This means several times the air venting capacity and therefore, very rapid heating up from a cold start.

When installed out-doors, they need no protection against freezing.

In the past, the use of thermostatic traps at pressures above say 50 p.s.i. has been restricted to small equipment because flexible bellows of sufficient strength could be made only in small sizes.

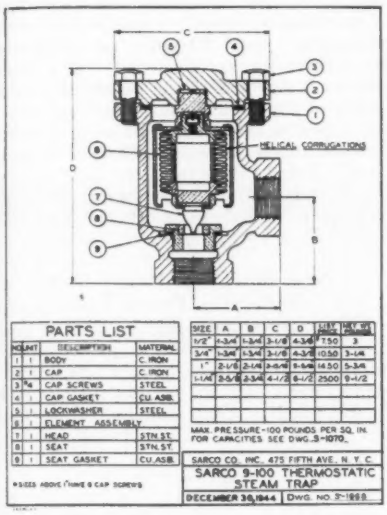
Sarco Co., Inc., 475 Fifth Ave., New York 17, N.Y., has (now) announced successful manufacture of bellows from heavy wall bronze tubing, drawn and helically corrugated in their own plant by methods developed by them.

These have made possible the introduction of an entirely new line of thermostatic steam traps, for pressures up to 225 p.s.i., using single, large diameter bellows, for inlet

• Keep Informed

sizes 1/2" to 2" inclusive, and with capacities double those of the company's well known No. 9 series.

The new traps are available in two pressure ranges, No. 9–100 for pressures 0 to 100 p.s.i. and No. 9–225 for pressures 0 to 225 p.s.i.



The construction may be gathered from our illustration. The heavy wall bellows is screwed into the end closures and the joints are sealed by brazing, using the latest electronic induction heating equipment.

Significant Comparisons

Capacities in pounds of condensate per hour at 100 lbs. pressure

Old No. 9 series		New No. 9 series	
1/2"	1300	1/2"	2500
3/4"	1600	3/4"	3400
1"	2000	1"	5200

These are actual capacities from tests under operating conditions with condensate temperature 20°F. below steam temperature. The corresponding capacities for cold water passing through the trap are approximately five times greater.

While in the old No. 9 series 1" was the largest size in which a single bellows could be used, all sizes of the new series, up to 2" incl. have single bellows.

Valve Orifices

New No. 9 Series		Standard Bucket Trap	Standard Float Trap
1/2"	3/8"	0.089	1/8"
3/4"	7/16"	5/32"	5/32"
1"	1/2"	13/64"	11/64"
1 1/4"	5/8"	19/64"	7/32"
1 1/2"	3/4"	11/32"	19/64"
2"	13/16"	3/8"	11/32"

Full information may be obtained by writing for bulletin S-1068.

New Bakelite Phenolic-Resorcinal Resin Glue Is Cold-Setting

Bakelite Corp. announces the introduction of XC-17613 —a cold-setting phenolic-resorcinal resin glue for wood bonding which provides maximum water resistance for exterior plywood applications. The properties of this new adhesive, which supplements "Bakelite" hot- and warm-setting resin glues, are described in detail in an 8-page Technical Data booklet, "Bakelite" Cold-Setting Phenolic Resin Glue XC-17613."

Written expressly to acquaint plywood and furniture manufacturers with the properties of this newest of the phenolic glues, the booklet is available on request to Bakelite Corp., 30 East 42nd Street, New York, 17, N. Y. This booklet explains formulations, mixing

Continued on Page 34

LASKER INTEGRATED FABRICATIONS

ENGINEERING WITHOUT HEADACHES!

The purchaser of the structural work, platforms, walkways, stairways, etc., serving the above apparatus was relieved of all the headaches attendant to design, purchase of materials, fabrication and erection of the equipment shown. All these functions were unified under a single responsibility—Lasker Engineering Service—including, in this instance, detail drawings from general outline drawings for the steel plate, sheet metal and structural work as well as all operations from purchasing through final erection in the plant. Lasker Integrated Fabrication service may also do away with your construction worries.

Users of this unusual service include: Nichols Engineering and Research Corp., Mutual Chemical Co., Maywood Chemical Co., and Consolidated Edison Co.

Please address inquiries to Department M.

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CODES

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POWER BOILERS
(Including Inspection rules)

Recommendations apply to the boiler proper and piping connections up to and including the valve or valves as required by the Code; also to superheaters, reheaters, economizers and other pressure parts connected directly to the boiler without intervening valves.

1943 Edition with 1944 Addenda $2.25

FOR BOILERS of

*Locomotives 75¢

*Steel and Cast Iron for Low Pressure Heating 75¢

Miniature (100 lb per sq in. maximum working pressure) 50¢

*1943 Editions *with 1944 Addenda*

UNFIRED PRESSURE VESSELS

Those subjected to external pressure and for gases or liquids at temperatures of —20 F and below. $1.50

MATERIAL SPECIFICATIONS

For important material used in construction of boilers and pressure vessels. $3.00

1943 Editions with 1944 Addenda

API-ASME CODE FOR UNFIRED PRESSURE VESSELS

For vessels subjected to external pressure, also fusion-welded, riveted and integrally forged vessels for petroleum liquids and/or gases within the limits prescribed in the Code.

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Published by

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 West 39th Street
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• Keep Informed . . .

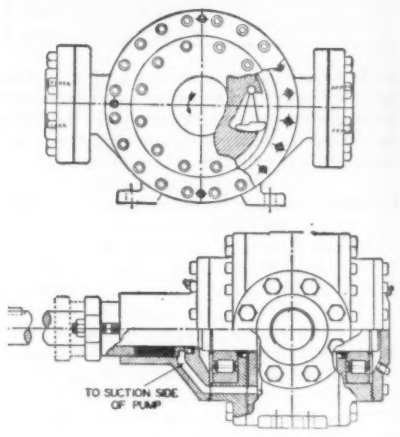
procedure, working life of glue, spreading, assembly; curing, cleaning, and storage. Illustrated with graphs that show pot life, assembly times, and clamp periods, the eight pages of technical data are simply and concisely written.

XC-17613 was specifically developed to meet demands for a cold-setting phenolic resin glue for the lamination of heavy lumber, beams, arches, and ships' timbers. It is also used for plywood glider fuselages, aircraft and marine construction and meets the necessary specifications for this work, including Army Air Forces Specification 14124.

Urea resin glues are arousing so much interest in the field that Bakelite Corporation has published a 12-page illustrated booklet on these glues for plywood and densified wood. The low cost, wet strength, and adaptability of the resins is covered, as well as the types of equipment used. Purposes for which they are best suited are discussed and a special chapter is devoted to the potential developments of the urea glues. Case histories of the experiences some of Bakelite Corporation's customers have had with these resins are cited. Titled "Bakelite Urea Resin Glues", the book is available to business executives on request to Bakelite Corp., 30 East 42nd Street, New York, 17, N. Y.

New Blackmer Heavy Duty Gathering Pump Unit

Designed for gathering in the oil fields, this new Blackmer Pump incorporates a number of important changes and improvements, according to an announcement by E. W. Chapman, Chief Engineer of the Blackmer Pump Co., Grand Rapids, Mich.



The specifications are as follows: capacity, 90 GPM; Pressure, to 500 psi; Mechanical efficiency at 500 psi, 85%; Suction pressure, 0 to 100 psi; Viscosities handled, 40 SSU to 500 SSU-Specific Gravity .82; and Power, Engine or Motor.

The pump, reduction gearing, clutch and prime mover are mounted on a fabricated steel skid making a compact unit, which is easily moved in the field.

Mr. Chapman states that the pump is equipped with special anti-friction bearings and that the stuffing box is so designed that vacuum is maintained on the packing chamber. The effect of the design is to practically eliminate leakage.

This unit is designed especially for outdoor service, and is therefore of particularly rugged construction.

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New Haven, Conn.

RATE Announcements under this heading in MECHANICAL ENGINEERING are inserted at the flat rate of $1.25 a line per issue, $1.00 a line to A.S.M.E members, minimum charge, three line basis. Uniform style set-up. Copy must be in hand not later than the 10th of the month preceding date of publication.

• Keep Informed

New Electrode for Heavy Weldments

A new heavily covered arc-welding electrode for flat and horizontal fillet welding as well as for flat butt welding has been announced by the Electric Welding Division of the General Electric Co. Desirable wherever weld requirements include high mechanic properties, rigid X-ray examination, good profile, high deposition rate, and good surface appearance, the applications of this electrode include pressure vessels and pertinent connections, heavy machine bases, and structural parts such as column plates, columns, roof trusses, beams, and girders where the thickness of the section permits.

Known as Type W-27, the new electrode is characterized by an exceptionally high melting rate which results in increased production and higher speeds at the same welding current as other electrodes. At comparable production speeds, Type W-27 requires less heat input to the joint, thus reducing warpage and internal cooling stresses. These features, plus its ability to operate through a wide range of current, and freedom from undercut, suggest the use of Type W-27 for a great many war production tasks.

Readily recognized by its steady, forceful, spray-type arc, the new electrode operates on alternating current or direct current with either straight or reverse polarity. It has low spatter loss and easy slag removal and produces welds of excellent appearance. It is available in three sizes: $^{3}/_{16}$ by 18 inches, $^{1}/_{4}$ by 18, and $^{5}/_{16}$ by 18 inches, and is rated A. W. S. classes E6020 and E6030.

New Bruning 55C Printer Speeds Semi-Photographic Reproductions

Designed to take full advantage of the time-saving features inherent in semi-photographic reproduction processes, a new printer, expecially adapted to this type of work, has just been announced by the Charles Bruning Co., Inc.

Used with the new semi-photographic materials, this new printer, known as the Bruning 55C Continuous Photographic Printer, provides clear and faithful duplicates of anything typed, printed, photographed or drawn. The 55C is a 42-inch printer, yet, owing to the exceptional compactness of its design, requires floor space of only 40 × 62 inches. It may be used either inside or outside of the dark room, and operates either with roll stock or cut sheets.

With a speed of 0 to 18 feet per minute, the Model 55C embodies improvements in light source and light control which assure maximum line opacity and clear, contrasting

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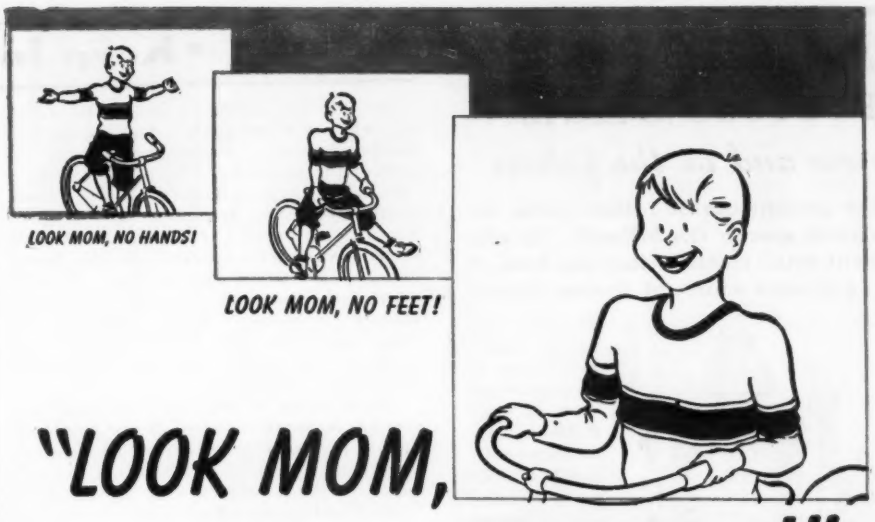

"LOOK MOM, NO TEETH!"

This is no joke. To Mom it is serious. And to you also "no teeth" is an important matter, if you use pressure gauges. Now you can get Certified Gauges with the new, patented Helicoid Movement and that means no teeth to wear out.

After serving in the Navy for several years, Certified Gauges are now available to industry for prompt delivery.

If you've had gauge trouble due to movements wearing out or getting sticky, investigate Certified. Try one on some really tough service. See for yourself how much longer they wear and remain accurate. Ask the man who uses them.

Only Certified Gauges are made with the Helicoid Movement. All Certified Gauges are guaranteed accurate to within ½ of 1%. Send for catalog today.

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Supplying
Process Steam...
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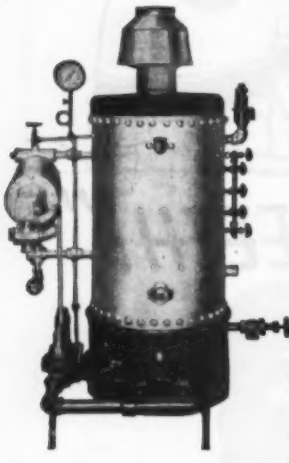
For present use or future plans, designers specify the MKayO. An efficient small steam boiler, gas-fired, it is a reliable source of process steam.



It is safe, conserves manpower and is an economical user of fuel. Built in accordance with ASME requirements for pressures up to 100 lbs., in sizes 3/4 to 5 H. P.

We invite engineering consultation . . . our experience of more than a third of a century in boiler work is at your disposal.

MEARS-KANE-O'NEILL
Manufacturers of Automatic Steam Boilers for over a third of a century
1943 1915 EAST HAGERT STREET, PHILADELPHIA 25, PA.

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prints. Either of its two fluorescent lamps, one white and one amber, may be used in making exposures, depending upon the nature of the originals. The printing light is effectively sealed for dark room use. A constant speed motor drives the variable speed transmission which is controlled by a knob easily in reach of the operator's hands. Speed changes are instant and positive. Further control of exposure is obtained by a unique shutter arrangement which varies the exposure space from 0 to 14 inches. Both the speed of the machine and the shutter are individually controlled.

In the design of this new printer, special care has been taken to provide the good contact so necessary in reproducing by a semi-photographic process. A 9-inch pyrex cylinder revolving contact with 22 individual 2-inch bands assures that originals and sensitive materials remain in register, and prevents any slippage which might cause blurred prints.

From the operator's point of view, the Bruning 55C Printer provides new ease and simplicity in making reproductions. A unique feature of the 55C is the execptionally large print return tray, which occupies the entire top of the machine. The originals enter the tray on top of the print, thus making possible easier handling of the work. By means of a foot pedal, the operator is able to reverse the travel of prints through the machine instantly. The adequately-sized feed board is illuminated to facilitate handling, and all controls are individually illuminated by means of ruby or safe lights. The machine is mounted on casters for easy moving, and is attractively finished in two-tone green crinkle finish.

The electrical requirements of the Model 55C are 4 amperes—operating 110 volts. The machine is wired for 100 volts A.C. 60 cycle, or 220 volts D.C.

According to Bruning officials, the 55C Printer fills a distinct need today, when manpower shortages and the necessity for speed require the utmost efficiency in printing equipment. With the 55C Printer, pencil tracings are quickly and easily intensified in the reproduction, thus saving drafting time and labor. Clear, sharp reproductions may be made of worn and soiled originals, thus obtaining a better negative than from a Van Dyke paper negative. Blue prints, layouts, maps and engineering data are quickly and easily reproduced. Originals which may be copied include those printed on one side or on both sides, on transparent or opaque materials. The printer facilities the making of copies on waterproof papers and cloths for templets.

The 55C Printer is one of a line of modern printing and developing machines introduced by the Charles Bruning Co., Inc.

• BUSINESS CHANGES

H. B. Higgins Elected Westinghouse Director

The election of Harry B. Higgins, President of the Pittsburgh Plate Glass Co., to the Board of Directors of the Westinghouse Electric & Mfg. Co. has been announced by A. W. Robertson, Chairman of Westinghouse.

Mr. Higgins, who was elected President of the Pittsburgh Plate Glass Co. in January 1944, has been associated with that company since 1905, when he was employed as a stenographer.

He was born September 7, 1881, in Newburyport, Massachusetts, son of the late James H. Higgins, publisher of the Boston papers Herald and Traveler. After attending public schools in Newburyport and being graduated from Harvard University, Mr. Higgins joined the Pittsburgh Plate Glass Co. in Minneapolis.

In 1912 he became manager of the company's Kansas City branch, and in 1917 was made manager of plate glass sales with offices in Pittsburgh. Mr. Higgins was appointed general sales manager in 1925, three years later was named vice president, and Executive Vice President in 1942. He is also a member of his company's Board of Directors.

Mr. Higgins is President and a director of the Pittsburgh Corning Corp., and a director of the Mellon National Bank and of the A. M. Byers Co.; and a trustee of the University of Pittsburgh, the Magee Hospital, Pittsburgh, and the Dollar Savings Bank of Pittsburgh.

Boomer Elected President of Girdler Corp.

George O. Boomer has been elected President of The Girdler Corp., Louisville, Ky., succeeding Walter H. Girdler, Sr., who died on January 7. He will also remain Vice President and a member of the board of directors of the firm's affiliate, Tube Turns, Inc. Mr. Boomer was a close friend and business associate of Mr. Girdler for many years.

Mr. Boomer has been a member of the board of directors of The Girdler Corp. since it was founded, and Executive Vice President since 1938. He was formerly Vice President of the Ewald Iron Co. and President of the Pittsburgh Fuel Co.

He is a director of the Louisville Branch of the Federal Reserve Bank of St. Louis,

For strength and simplicity, only two parts are used — bearing bars which carry the load and have curved slots punched ABOVE THE NEUTRAL AXIS, and cross bars, of the same cross sectional area as the slot itself, pressed into these slots to distribute the load. No rivets, bolts or welds are required, thus eliminating the possibility of loose joints. Tri-Lok flooring comes in rectangular, diagonal and U shapes with Safety Steps — ask for Bulletin 1140 — DRAVO CORPORATION, NATIONAL DEPARTMENT, 300 Penn Avenue, Pittsburgh (22), Pa. (Distributor for THE TRI-LOC COMPANY)

DRAVO

Keep Informed

Ewald Iron Co., the Louisville Industrial Foundation and the Louisville Board of Trade.

The Girdler Corp. has three divisions: The Votator Division, the Gas Processes Division, and the Thermex Division.

Fritsch Elected President of Tube Turns

R. E. Fritsch, Vice President of Tube Turns, Louisville, Ky., since 1929, has been elected President, succeeding Walter H. Girdler, Sr., who died on January 7. He joined Mr. Girdler when Tube Turns was originally organized and he has had a major part in the firm's rapid growth.

Mr. Fritsch continues as Vice President and a member of the board of directors of The Girdler Corp., of which Tube Turns is an affiliate. He is a member of the American Society for Metals and the American Welding Society.

Tube Turns manufactures seamless welding fittings and flanges for ships, power plants refineries and many other purposes, and is a large-scale producer of aluminum and steel forgings for industry.

Kennametal Appoints Hudgins Plant Superintendent

Kennametal Inc. of Latrobe, Pa., has appointed R. S. Hudgins as Plant Superintendent, succeeding W. E. Newcomer, resigned.

Mr. Hudgins was graduated from the Virginia Polytechnic Institute in 1934, with the degree of B.S. in Mechanical Engineering. For six years thereafter he was employed by the Ingersoll Rand Company, serving successively as machine operator, Inspector, Foreman, assistant departmental Superintendent, and Production Engineer. Following that he was Machine Tool Supervisor for one year in the munitions division of the American Type Founders.

He entered the employ of Kennametal Inc. in December 1941 as their Tool Engineer and Representative at West Hartford, Conn., and has been serving in that capacity until his promotion on January 1 of this year. He is a member of the American Society of Tool Engineers.

Wickwire Spencer Elects R. T. Dunlap Director

The Wickwire Spencer Steel Co. announced the election of Robert T. Dunlap as a member of the Board of Directors. Mr. Dunlap has been associated with Wickwire Spencer since 1943. He is also Vice-President in charge of production of Wickwire Spencer.

Well known in the steel industry, under Mr. Dunlap's direction the operating efficiency of the various Wickwire Spencer plants and steel mills has been greatly increased through improvement and rehabilitation of facilities and the installation of production economy.

Mr. Dunlap will continue to make his headquarters in Buffalo at the Company's plant at River Road.

Twin Disc Announces Opening of Regional Office in Michigan

G. M. (Tid) Guilbert has been appointed manager of the Twin Disc Clutch Co.'s newly-created regional office at Lansing, Michigan, according to an announcement by N. F. Adamson, general sales manager for Twin Disc. The new territory formerly was served from the Cleveland regional office.

"This new office has been established," Mr. Adamson stated, "in order to better serve the many Michigan manufacturers who are greatly expanding their use of our

Continued on Page 39

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...and a fact that's important to YOU, who depend upon the pencil tracings for blue-prints that do justice to your skill. The finer grain in HI-DENSITY Microtomic Leads results in sharper, clearer lines with *less* pressure... and easier erasures. Use Microtomic "Van Dyke" and be that much more certain of foolproof reproduction.

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The EBERHARD FABER Drawing Pencil in 18 degrees, 7B to 9H plus 6 degrees with special Chisel Point Leads.

Free Sample

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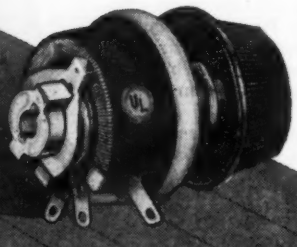
10 Wattage Sizes

. . . in a variety of types to meet every need

There's an Ohmite Rheostat to assure the best unit for each control need . . . from the 1000 watt, 12″ diameter, Model "U" to the 25 watt, 1 9/16″ diameter, Model "H". Made in single or tandem units, with uniform or tapered windings, in stock or special resistance values. And large or small—each Ohmite Rheostat is designed to give smooth, close control—long life—and trouble-free service. In Resistance Control, Ohmite Experience Makes a Difference.

Write on company letterhead for Catalog and Engineering Manual No. 40.

OHMITE MANUFACTURING CO.
4807 Flournoy St., Chicago 44



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RHEOSTATS • RESISTORS • TAP SWITCHES

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hydraulic drives, industrial clutches and marine gears in their products."

Mr. Guilbert is a 20-year veteran with the Twin Disc Clutch Co., having served this concern in various important executive capacities. Due to his wide acquaintance among manufacturers and his intimate knowledge of Twin Disc products and their applications, he was considered an ideal choice for this important new assignment. Just prior to his appointment as manager of the Michigan region, Mr. Guilbert completed an extensive nation-wide survey to determine the future requirements of equipment for the transmission and control of power in industrial applications.

Executive offices for the new region are situated at 2200 Olds Tower Building, Lansing 8, Michigan. According to Mr. Guilbert, a complete engineering service for Michigan manufacturers will be provided by the regional office as soon as possible.

The Twin Disc Clutch Co.'s line includes marine reverse and reduction gears, machine tool clutches, farm tractor clutches and power take-offs, heavy-duty clutches, reduction gears, power take-off units, hydraulic couplings, and hydraulic torque converters of the Lysholm-Smith type. The company and its employees have won several Army-Navy "E" awards for efficiency in war production.

Blackmer Pump Announces Representative for Mexico

Jose Maria Fierro, who has been acting as Blackmer Representative in Mexico City and the adjoining districts, has been appointed General Representative for all of Mexico, effective January 1, 1945.

Mr. Fierro has enlarged his selling activities and is building an organization which will adequately cover all of the major markets for rotary pumping equipment in Mexico.

This announcement is made by J. B. Trotman, General Sales Manager of the Blackmer Pump Company, Grand Rapids, Michigan.

Riddle Responsible for G-E Apparatus Dept. Media

Responsibility for media in the advertising of General Electric's Apparatus Department products has been assigned to G. W. N. Riddle, according to an announcement by W. V. Merrihue, Manager of the Advertising and Sales Promotion Divisions.

Mr. Riddle has been engaged in market research work for General Electric since August, 1943. For 14 years prior to that date, he was on the staff of the Chairman of the Board, serving under both Owen D. Young and P. D. Reed. Born in Brighton, England, Mr. Riddle came to the United States in 1922. He was graduated from Harvard in 1929 with the degree of Bachelor of Science, and subsequently received his Master's degree from Columbia University.

American Brake Shoe Appoints Annich Superintendent of Standards

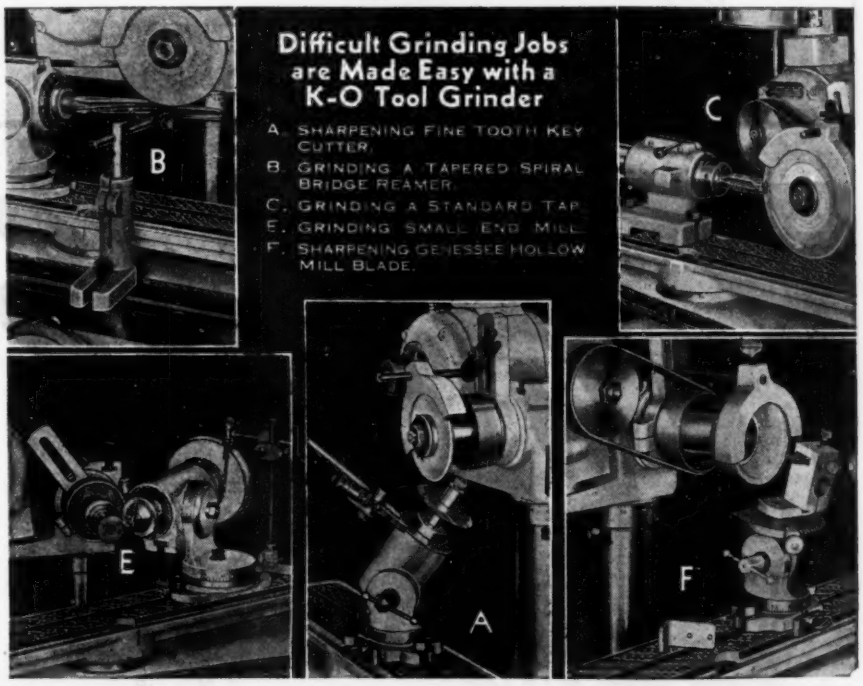
William B. Given, Jr., President of American Brake Shoe Co., announces the appointment of Milton Annich as Superintendent of Standards for all Brake Shoe's nine divisions.

Mr. Annich rejoined the Brake Shoe organization after nearly two years' service with the Army in which he was commissioned as a First Lieutenant in the combat engineers. He will coordinate standard production and standard costs and assist division operating heads in expanding the standards system.

A graduate of the University of Pennsylvania, Mr. Annich joined the Brake Shoe organization as an apprentice in the Mahwah,

Continued on Page 40

Cutting Tools Must Be Conditioned for Post War Production, Too!


Difficult Grinding Jobs are Made Easy with a K-O Tool Grinder
A. SHARPENING FINE TOOTH KEY CUTTER.
B. GRINDING A TAPERED SPIRAL BRIDGE REAMER.
C. GRINDING A STANDARD TAP.
E. GRINDING SMALL END MILL.
F. SHARPENING GENESSEE HOLLOW MILL BLADE.
B
C
E
A
F

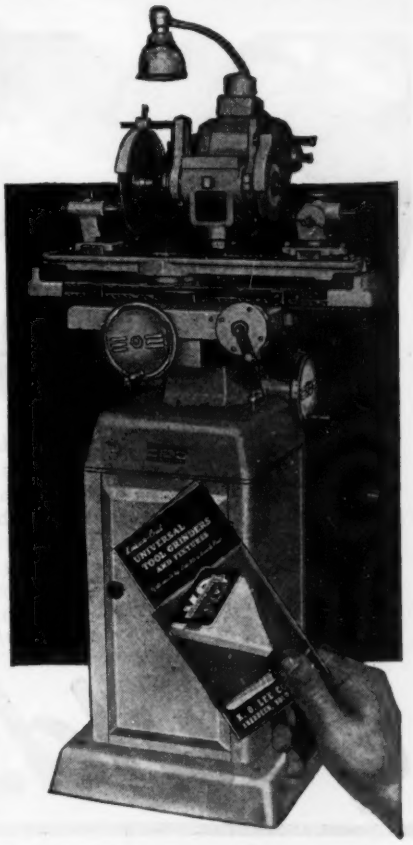
Not All Men and Machines Can Be Released When the War Ends . . . Some Must Stay on the Job!

When the war broke out, *Knock-Out* Tool Grinders were ready! They've been doing a Titan's job on production work and on tool maintenance throughout the nation and all allied countries. Now as the peace approaches, and thinking men are readying their plants for the tremendous production job which lies ahead, *Knock-Out* Grinders are again ready to accept the challenge!

***Knock-Out* engineers have continually stayed on the alert giving users of K-O Tool Grinders many advantages, making difficult grinding jobs easy.**

Single Speed or Multi Speed Wheel Heads are available. Wheels ranging from 1 to 10 inches can be used. Tools from the smallest to 12 inches in diameter can be ground with speed and accuracy.

When writing for literature ask for Unit No. 33-35



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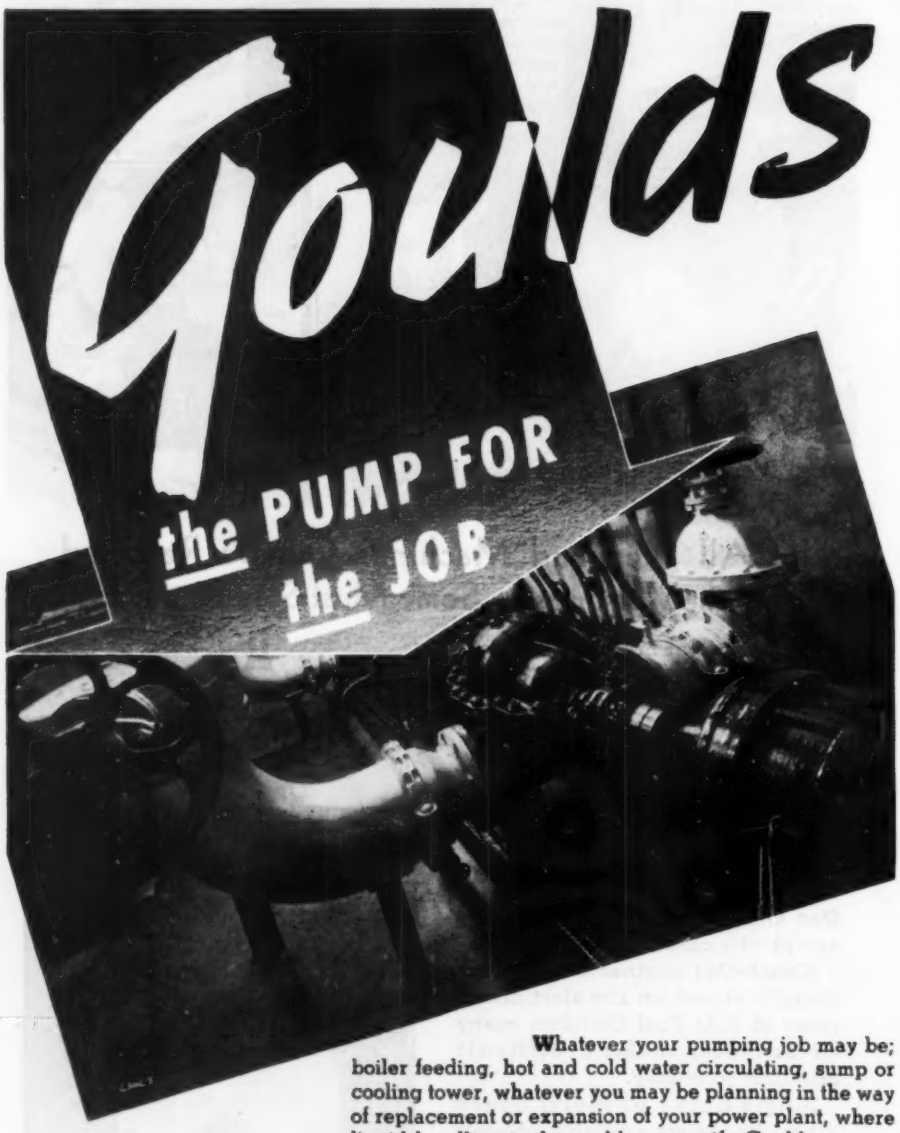

Whatever your pumping job may be; boiler feeding, hot and cold water circulating, sump or cooling tower, whatever you may be planning in the way of replacement or expansion of your power plant, where liquid handling is the problem, specify Goulds.

Specializing in pump building only, for 96 years gives Goulds the engineering knowledge and skill plus a complete line of centrifugal, rotary and reciprocating pumps that can select for you the size and type to provide you with "*the* pump for *the* job."

Goulds PUMPS INC.
SENECA FALLS, N. Y.

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N. J. plant in 1933. He also worked in the company's plants in Baltimore, Md., Chattanooga, Tenn. and Portland, Ore., returning to the Mahwah plant as head of the Standards department of the Brake Shoe & Castings Division in 1939.

Wickwire Spencer Appoints Allington Assistant General Sales Manager

E. P. Holder, President of the Wickwire Spencer Steel Co., announces the appointment of H. C. Allington as Assistant General Sales Manager of the Wickwire Spencer Co. and its subsidiary the American Wire Fabrics Corp.

Mr. Allington became associated with Wickwire Spencer in February, 1944 as Sales Research Engineer in charge of the development and expansion of markets for the Company's products. Prior to joining Wickwire Spencer, Mr. Allington was with the Logan-Allington Co., Inc. and the American Machine & Metals, Inc.

In his new position, Mr. Allington will continue his work on market development and expansion. He will also supervise the activities of the Company's various sales divisions and develop policies in line with Wickwire Spencer's currently expanded operations.

Mr. Allington will be located at the Company's executives offices, 500 Fifth Avenue, New York 18, New York.

Heath Joins Climax Molybdenum

R. L. Heath recently joined the Climax Molybdenum Co. in the capacity of metallurgical engineer. His headquarters at present are in St. Louis, Mo.

Before coming with Climax he was Chief Metallurgist of the Allison Division of General Motors Corp. at Indianapolis, Ind. While there he served on several S.A.E. committees dealing with aircraft engine materials and packaging.

Mr. Heath was also active in the American Society for Metals, having been chairman of the Indianapolis Chapter, and chairman of the Constitution and By-Laws Committee in 1940–41.

Bray Returns to De Laval

Charles C. Bray has been appointed Assistant to the Manager of the Worm Gear Div. of the De Laval Steam Turbine Co. Prior to accepting this position, he served as a metallurgist for the Special Steel Department of the Philadelphia Office of Joseph T. Ryerson & Sons. Mr. Bray is not a newcomer to the De Laval organization, having served for ten years as a worm gear sales engineer in the De Laval Chicago Office before leaving to join the Ryerson organization.

Yezbak Appointed by Timken

John J. Yezbak has been appointed Manager of Public Relations as well as the News Bureau of The Timken Roller Bearing Co., Canton, Ohio, according to an announcement made by Company officials. Yezbak, who has been head of the firm's news bureau since

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joining the company in June, 1943, is a graduate of New York University.

A former Pennsylvanian, Yezbak has been editor of The Barnesboro (Pa.) Star, an advertising agency account executive with Belden Associates in Cleveland; and for several years prior to his association with The Timken Company, operated his own advertising agency in Cleveland.

The newly-created Public Relations Department was organized to co-ordinate all public relations activities of the Company.

Flickinger Appointed Kennametal Purchasing Agent

Richard J. Flickinger has been appointed Purchasing Agent for Kennametal Inc. of Latrobe, Pa. He is a graduate of Pennsylvania State College in Commerce and Finance with 11 years' experience in general banking, and for three years has been a statistical assistant to Kennametal's Chief Engineer.

New Homestead Valve Plant

Production starts this week in Homestead Valve Manufacturing Co.'s new cleaning-compound manufacturing plant at Edgeworth, Pa., across the Ohio River from the company's main plant in the hills near Coraopolis.

F. E. Schuchman, General Manager of the Company, states that the new plant will supply industry and all branches of the armed forces with compounds for Hypressure Jennys and other steam spray cleaning machines, to restore machinery, tanks, planes, trucks, bulldozers, and other war materiel to "fighting-trim," eight to ten times faster than by hand-cleaning methods. The plant will also make compounds for use with "dip-tank," "soaker-tank," and other methods of cleaning in essential industries.

Built by Rose and Fisher, Contractors, the new plant is on the main line of the Pennsylvania Railroad, and has its own railroad-siding facilities for handling carload shipments of raw materials or finished products. Good shipping facilities, plus a capacity several times greater than that of the former plant, promise greatly stepped-up delivery of Homestead's" compounds.

Executive Changes in the Lunkenheimer Co.

Frank P. Rhame, a Director and Vice-President and Assistant General Manager of The Lunkenheimer Co., valve manufacturers, has been made General Manager, succeeding Charles A. Brown, who retired December 31. Mr. Rhame has been associated with The Lunkenheimer Co. for over 25 years. Homer E. Lunken, a Director, succeeds him as Assistant General Manager.

Carra L. Lane, a production man of wide experience in valves and related products, has been named Works Manager, succeeding George A. Seyler, who announced his retirement as Vice-President in Charge of Manufacturing in September, effective December 31.

Fred H. Hehemann, Assistant Chief Engineer, becomes Chief Engineer, succeeding Jerome J. Aull, who retired December 31 after nearly 50 years of service with The Lunkenheimer Co. Hehemann has been with the company since 1904.

Harry A. Burdorf, widely known in the Valves and Fittings Industry and distribu-

Continued on Page 42

air THE *Economical* WAY TO MOVE MANY MATERIALS

Pneumatic conveying (under pressure or suction) of bulk or granular materials is finding ever-increasing favor as a definite means of saving time and moving materials economically. Naturally, such applications often place very severe operating conditions on the air moving equipment—that's why Engineers, desiring performance-proven units with a record of trouble-free service and long life expectancy, specify Roots-Connersville Positive Displacement Blowers or Vacuum Pumps.

"R-C" Blowers have the inherent ability to build up pressures needed to keep material moving in the conveying line. Furthermore, the material being handled is not contaminated because these blowers employ no internal liquid seals or lubrication. This is of special importance in the handling of food products.

Bulletin 22-23-B-11 sent on request.

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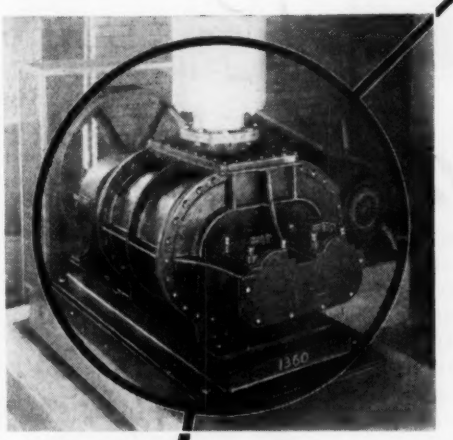
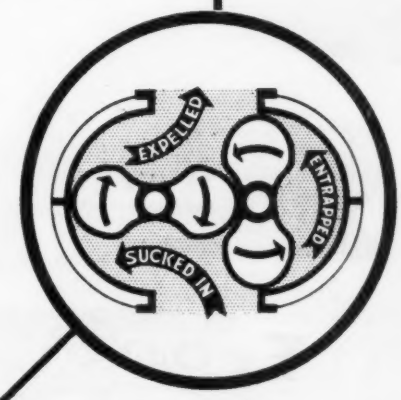
Photo shows "R-C" Vacuum Pump moving ashes from sludge incinerators—under severe service conditions. Capacity of this unit is 1,700 CFM, at 478 RPM, producing 7½" Hg. vacuum.





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The Principle is simple and effective

Twin impellers alternately suck in, momentarily entrap, and then expel definitely measured amounts of air, resulting in the delivery of four equal, predetermined volumes each revolution of the drive shaft. Impellers need no seal or lubrication. Capacity varies with speed. Pressure or suction automatically builds up to overcome resistance to flow.

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Roots CONNERSVILLE SINCE 1854

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FOR PNEUMATIC CONVEYING SYSTEMS

tive channels, remains as a Director and Vice-President in Charge of Sales.

Eshelby F. Lunken remains as a Director and President of the company; Chester C. Isekeit as a Director and Treasurer; and Charles W. Burrage as Secretary.

New Johns-Manville Engineering Department

Organization of a new Engineering Department of Johns-Manville Corp. was revealed recently with the announcement of the election of Kenneth W. Huffine as Vice-President of the Johns-Manville Products Corp.

Formerly manager of the Johns-Manville plant at Waukegan, Ill., Mr. Huffine in his new capacity will be in charge of the new department at New York Headquarters created to consolidate engineering activities in the mining and manufacturing division to meet the production demands of wartime operations, and to expand plant engineering programs in preparation for post-war production plans of the company.

Mr. Huffine, a native of Kerlin, Indiana, is a graduate of Purdue University where he captained the football team in 1919 and was named on several "All-American" teams. Following his graduation he played professional football and was a member of the original Chicago Bears team.

Prior to his association with Johns-Manville, he held engineering positions with the Interstate Steel Mill, the Webster Engineering Co., General Motors Corp. and the Banner Rock Products Co. He became affiliated with Johns-Manville when the Banner Rock firm merged with Johns-Manville in 1929.

In his new position, Mr. Huffine will have offices in New York City.

Gilbert D. Dill Joins American Foundry Equipment Co. Sales Engineering Staff

Gilbert D. Dill has been appointed a member of the sales engineering staff of American Foundry Equipment Co., Mishawaka, Ind. He will be engaged in the development and application of Wheelabrator airless abrasive blast cleaning equipment in the rolling mill industry.

Mr. Dill was last employed as purchasng engineer for Arthur G. McKee & Co., Cleveland, in charge of purchases involved in the construction of two wartime steel plants. He also holds patents on several important industrial developments including the Brassert Stationary Disintegrator for gas and oil reactions, which is widely used in the steel and chemical industries for dust collection absorption and other reactions.

Link-Belt Moves Huntington, W. Va. Office

Link-Belt Co. announce that, in order to provide larger and more conveniently-located quarters, they have moved their Huntington, W. Va. office from 2840 North Staunton Road to Suite 1301–1302 in the modern West Virginia Building, located at the corner of Fourth Avenue & 9th Street, postal zone 9. The new telephone number is 4455.

"Dave" W. Stevens, the district manager in charge, says that the new location provides the added facilities that have long been needed to handle the increased volume of vital business done with the coal mining companies, chemical plants and other industrial establishments within the territory.

Mr. Stevens entered the company employ in 1912 at Philadelphia. He is well known as a designer of coal tipple equipment, and has been located at Huntington since 1925.

Buffalo Forge Appointments

Buffalo Forge Co., Buffalo, N.Y. announces the appointment of N. R. Johnson to the position of Factory Manager. Mr. Johnson has been connected with the Company for 28 years and for a number of years has been General Purchasing Agent. His outside contacts, as well as a thorough knowledge of the Company's products and manufacturing problems fit him particularly well for the new post.

At the same time the Company announces the appointment of H. D. Hebard to Director of Purchases. Mr. Hebard has been with the Company for 24 years, most of this time in sales work. For the past three years he has been assistant to Mr. Johnson in the Purchasing Department.

Gilbert H. Gaus Heads Gardner-Denver New York Office

Gilbert H. Gaus has recently been appointed manager of the Gardner-Denver Co's. New York branch office at 76 Ninth Ave. He succeeds G. V. Leece, vice-president, who has been placed in charge of the company's Export Division.

To his new position, Mr. Gaus brings a wealth of practical experience. For the past seven years he has been with the Gardner-Denver New York Office as sales engineer, handling all products manufactured by the company. Previous to joining the company in 1938, he had 18 years' experience in engi-

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DOUBLE SUCTION
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Now Ready!
Catalog A-145, just off the press, covers an entire range of Centrifugal Pumps especially engineered for industrial, municipal and other water supply systems. Cross-section illustrations, performance curves and structural details show at a glance why users of Economy Pumps save in cost, power, labor. Selection tables simplify the choice of exact types and sizes to handle specific requirements. A copy of the Catalog is yours for the asking, on your letterhead. So are the services of our engineering staff—for special problems—without obligation.
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neering and sales in the New York area, on pumps and other mechanical and electrical equipment for industrial plants, power plants, water works and sewage plants.

Mr. Gaus studied mechanical and electrical engineering at the Massachusetts Institute of Technology and was graduated in 1917. He entered the Army and during World War I was a first lieutenant in the Coast Artillery Corps. Since 1925, he has been a Licensed Professional Engineer in the State of New York.

Graver Tank Appoints Springer Eastern Sales Manager

Announcement has been made of the appointment of Chas. W. Springer as Manager of Eastern Sales by the Graver Tank & Mfg. Co., Inc. of East Chicago, Indiana.

Mr. Springer—formerly Sales Manager, Barrel Division, Jones and Laughlin Steel Co. and familiar to many as a representative of the Chicago Bridge and Iron Co.—brings to the Graver organization a well rounded background of executive sales direction in the steel plate and allied fields.

Mr. Springer will direct all of Graver's east coast sales activities from the company's offices at 424 Madison Ave., (17) New York, N.Y.

Carrier Corporation International Division Moves to Midtown Office

Heman Greenwood, vice president of Carrier Corp's. International Division, made known that, after Monday, January 22, the Division will be located in the heart of New York City at 122 East 42nd Street, the Chanin Building. The new headquarters will house all of Carrier's International Division officers and employees.

• LATEST CATALOGS

Air Handling Equipment

"What We Make"—a 199-page pocket size catalog and engineering data book, containing description of complete line of air handling equipment and its application in a variety of industrial systems such as heating, ventilating, industrial air conditioning, drying, dust control, fume exhaust, vacuum cleaning, vapor absorption, etc. Catalog includes description of construction, sizes, and condensed performance tables. Fully illustrated with photos of units, system applications and sectional drawings. Also included are more than 80 pages of engineering and design data, some of which has not previously appeared in printed form, and is derived from many years' experience and research in air handling applications. Also many often-used formulas and tables and a new original psychrometric chart for determining values of air properties in heating, cooling, humidifying and dehumidifying problems. For a copy of "What We Make", write on your company letterhead to B. F. Sturtevant Co., Hyde Park, Boston, 36, Mass.

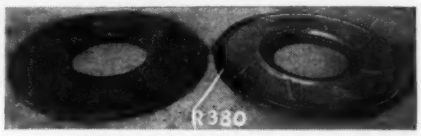
Taylor Makes Flex-O-Timer Catalog Revision

A number of important revisions have been made in the new Flex-O-Timer Catalog No. 98154, just published by the Taylor Instrument Cos. of Rochester, N. Y. These changes will be of particular interest to production men in the Engineering industry who are now studying their product with an eye to increasing output, improving quality, or reducing costs by the use of Time Cycle Controllers.

Continued on Page 44

Non-Magnetic Manganese Steel Is Also *Shock and Abrasion Resistant*

There are other non-magnetic metals, but where resistance to shock stresses and abrasion is essential, as well as non-magnetism, 10-14% manganese steel is often chosen. This steel is almost completely non-magnetic, having a permeability of



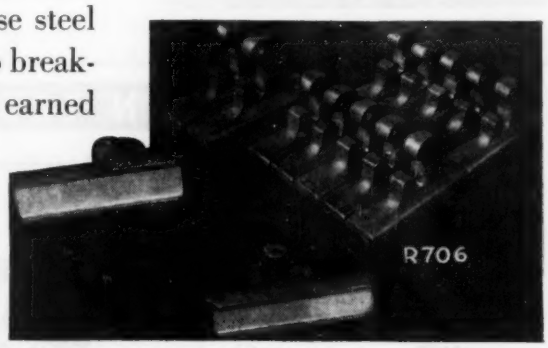
about 1.3 without surface preparation. Its price is lower than alloys with comparable properties unless extensive machining is required.

Austenitic manganese steel has a high resistance to breakage stresses, which has earned its title of "The Toughest Steel Known." It work-hardens on the surface under repeated blows, a phenomenon by which its abrasion resistance is increased in service.

The pictures show some of the non-magnetic uses to which manganese steel castings have been applied.

R-380. Bottom plate or coil shield for a lifting magnet. It is subjected to heavy shocks when the magnet is dropped onto the pile to level out the material, and when the powerful current causes rising pieces to strike the plate with tremendous blows. Manganese steel cover plates are used on all makes of industrial lifting magnets.

R-706. Collector shoes for overhead traveling cranes are made of manganese steel not only for its extreme toughness and wear resistance, but because its non-magnetic property assures ready release from the rail.



Send for Bulletin 1144-NM, which pictures other non-magnetic applications for manganese steel.

Long lasting, wear resistant gears, sprockets, sheaves, wheels and rollers of manganese steel are described in Bulletin 842-WS.

Amsco
AMERICAN MANGANESE STEEL DIVISION
Chicago Heights, Illinois

AMERICAN Brake Shoe COMPANY

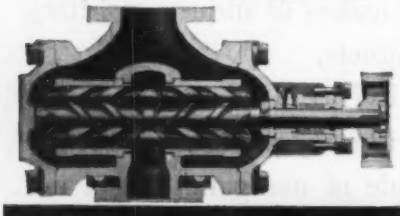
FOUNDRIES AT CHICAGO HEIGHTS, ILL.; NEW CASTLE, DEL.; DENVER, COLO.; OAKLAND, CALIF.; LOS ANGELES, CALIF.; ST. LOUIS, MO.
OFFICES IN PRINCIPAL CITIES

The IMO OIL PUMP
Small but Effective

LIKE THE SUBMARINE ON WHICH IT IS USED

The submarine represents the most concentrated power known to naval warfare. Similarly, the IMO oil pump provides great concentration of pumping capacity in small space. It is extremely compact, rugged, simple and reliable, having only three moving parts and no valves or pilot gears.

The IMO oil pump is used on submarines for pumping both fuel and lubricating oils. You can use this small, but effective, pump for handling oil of practically any viscosity, in any volume, and at any pressure. Ask for Leaflet 1-112.



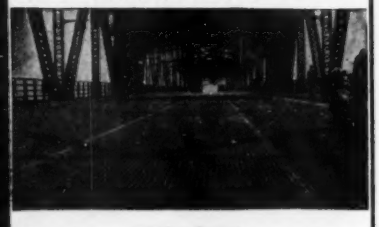
IMO PUMP DIVISION
of the De Laval Steam Turbine Company
Trenton 2, New Jersey

IRVING DECKING

BRIDGE FLOORING

OPEN STEEL GRID
SAFETY
Permanent Inwrought Traction
Self-Cleaning Surface

LIGHTWEIGHT
Only 15¼ lbs. per sq. ft.



ECONOMY
Minimum Maintenance
Non-Erasible Lane Markers
Restores Old Bridges
Reduces Cost of New Bridges
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IRVING SUBWAY GRATING CO., INC.
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LONG ISLAND CITY 1, NEW YORK
WESTERN DIVISION: FOOT OF PARK AVE.
EMERYVILLE 8, CALIFORNIA

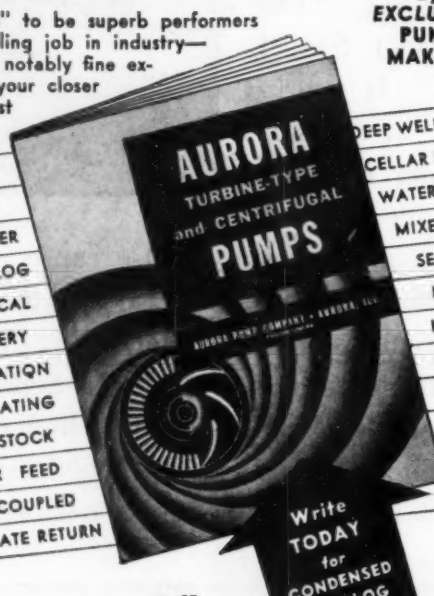
PUMPS YOU CAN TRUST

You'll find "PUMPS by Aurora" to be superb performers for virtually every liquids handling job in industry—not all, but most—and each a notably fine example of its kind. We invite your closer acquaintance with these highest standard pumping units.

BUILT by EXCLUSIVE PUMP MAKERS

WE BUILD OUR PUMPS *in the* BELIEF *that* EVERY PUMPING JOB *is* IMPORTANT

SUMP
BILGE
TRANSFER
NON-CLOG
CHEMICAL
REFINERY
DISTILLATION
CIRCULATING
PAPER STOCK
BOILER FEED
CLOSE-COUPLED
CONDENSATE RETURN



DEEP WELL TURBINES
CELLAR DRAINERS
WATER SYSTEMS
MIXED FLOW
SEWAGE
BRINE
HOUSE
DAIRY
FARM
AND
MANY
OTHERS

Write TODAY for CONDENSED CATALOG

— or See Our Catalog in SWEETS

DISTRIBUTORS IN PRINCIPAL CITIES

AURORA Always PUMPS

AURORA PUMP COMPANY

96 Loucks Street, AURORA, ILLINOIS

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The purpose of the Flex-O-Timer is to time precisely the sequence and duration of operations involving temperature, pressure, humidity or combinations of each.

Operators of platen presses or other applications which require frequent changes in the duration of one phase of a cycle will read with interest the section devoted to the small Auxiliary Timer which fits in the case of the Flex-O-Timer. Explanation of this Auxiliary Timer is accompanied by diagrams of several typical platen press installations for plastic molding.

Large, clear photographs show some of the latest applications of the Flex-O-Timer in such processes as the curing of synthetic rubber tires, the coordinated control of a package dye machine, steam peeling of root vegetables and tobacco conditioning. Manufacturers of standard machinery used in these and many other comparable processes are discovering the sales advantages of equipping their products with Flex-O-Timers right at the factory. It saves their customers delay in getting into production, and assures them of enjoying efficient, economical control in their plants.

A copy of this catalog will be forwarded by the Company upon request.

Fuel Oil Pumping and Heating Unit Systems

Bulletin OB-37, 16 pages specifications and illustrations of various equipment arrangements build into a complete unit system to handle all grades of fuel oil as required for every type of oil burner. The Engineer Co., 75 West St., New York, 6, N.Y.

Apron and Pan Feeders and Conveyors

The Chain Belt Co. of Milwaukee announces a new bulletin No. 462 descriptive of Rex apron and pan feeders and conveyors. Rex apron and pan conveyors are used for handling coal, coke, ore, cement, rock, chemicals, bulk parts and many other materials. The bulletin contains design details, cross sections, capacity tables and specifications tabulated for quick comparison.

In addition to apron and pan conveyors, Chain Belt Co. manufactures a complete line of other conveying and bulk handling machinery, process equipment and more than 2,000 sizes and types of chain belts for the handling of materials, transmission of power, and timing of operations.

Bulletin No. 462 is available by writing Chain Belt Co., 1600 W. Bruce St., Milwaukee 4, Wis. or the branch office nearest to you.

Westinghouse Announces Thermostatic Control Booklet

For safe, accurate, automatic control of temperatures up to 650° F., seven types of bi-metal thermostats to fill a wide range of applications are described in a new booklet announced by Westinghouse Electric & Manufacturing Co.

The new 20-page booklet describes and pictures (1) the Built-in Watchman Thermostat, for aircraft equipment, instrument and bandage sterilizers, motor and wiring protection, vulcanizers, radio equipment, oil purifiers and flat-irons; (2) the Clostemp Thermostat, for applications where space is limited such as in platens, irons and vulcanizers; (3) Uni-Therm thermostat, combining close control with small size and simple, compact mounting; (4) the Sentinel Thermostat, for roasters, water heaters, dehydrators and casseroles; (5) Guardsman thermostat, particularly designed for sealing machines, ironing machines and other low-

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wattage heating applications; (6) Water Heater thermostat, for domestic storage type heaters; and (7) the Motorguard, for use on fractional and integral horsepower motors.

Characteristics and capacities of each unit are discussed and tabled for easy selection, and cross sections, curves and drawings illustrate operation and proper mounting of units.

Copies of the booklet may be secured from P. O. Box 868, Westinghouse Electric & Manufacturing Co., Pittsburgh 30, Pa.

Feedwater Treatment for High Pressure Boilers

L. F. Wirth and C. E. Joos describes feedwater treatment in 1400£ pressure boilers installed at the Dow Chemical Co.'s Midland, Michigan, plant.

The article is distinctive in that equipment is used in a manner that is unusual and the results obtained are exceptionally satisfactory. It is an article that is worth reading by all engineers interested in the treatment of feed water for high pressure boilers, and is available for the asking. Write Cochrane Corp., Philadelphia, Pa. and ask for Reprint No. 37.

Combustion Control Equipment

Bulletin BD-44, 12 pages describing a practical low cost balanced draft system that automatically controls furnace pressure, steam pressure, fans and stokers. The Enco Balanced Draft has been in use for over 25 years on more than 1,000 boilers in prominent power plants. The Engineer Co., 75 West St., New York 6, N.Y.

Fluid Handling Equipment

J. A. Zurn Mfg. Co., Erie, Pa. has recently published a Fluid Handling Equipment Catalog No. 45 which describes a complete line of tested devices for the protection of operating equipment connected with the piping systems utilized in industrial, processing and power plants.

This catalog features a complete line of suction and pressure line fittings such as Duplex Vertical & Horizontal Chamber type Strainers, "Y" Strainers, Angle type Strainers, 90° offset pressure and 180° straight-through pressure strainers, and remote valve control assemblies.

Other products described are interceptors for grease, wax, fats, oils, lint and solids such as metals, plastics, glass, etc.; vents, valves and drains.

Automatic Retractable Electric-Oil Ignition System

For lighting off pulverized coal, oil or gas with remote control. Bulletin OB-PC, 32 pages showing the application and explaining the operation of an automatic system to light off fuel burners and retract the ignition system out of the hot zone by remote control. The Engineer Co., 75 West St., New York 6, N.Y.

New Pump Book Published by Roper to Aid Engineers and Servicemen

In an effort to assist engineers and servicemen concerned with the operation, purchase or sale of pumps in the Marine, Manufacturing, Petroleum and Process industries, the Geo. D. Roper Corp., Rockford, Illinois, have published a new book entitled "How to Solve Pumping Problems."

The book is designed to aid the beginner as well as the experienced pump engineer. It outlines, step by step, the basic fundamentals used in estimating the requirements of the average pumping job. By simple language and the example method, it explains the formula used in figuring suction lift and dis-

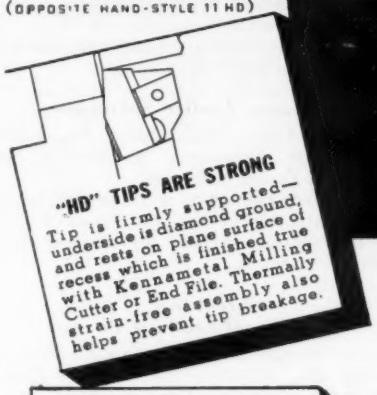
Continued on Page 46

Introducing —

KENNAMETAL "HD" TOOLS

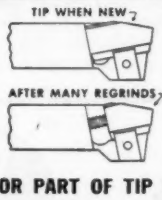
WITH CLAMPED-IN, ADVANCEABLE KENNAMETAL TIPS

STYLE 12 HD
(OPPOSITE HAND-STYLE 11 HD)



"HD" TIPS ARE STRONG

Tip is firmly supported—underside is diamond ground, and rests on plane surface of recess which is finished true with Kennametal Milling Cutter or End File. Thermally strain-free assembly also helps prevent tip breakage.



MAJOR PART OF TIP USED

When dull, tip can be advanced, and resharpened time and again, until the major part of it has been used.

ECONOMICAL REGRINDING

Only the tip is reground—no shank steel is removed. Operation is fast—clogging of diamond wheel grinder with steel is prevented.

for **HEAVY-DUTY** Machining on Steel and Cast Iron

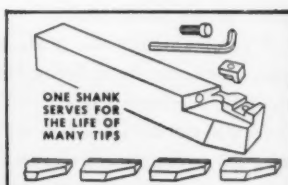
Kennametal HD Clamped-On Tools make practicable high rate carbide machining on heavy steel forgings, castings, and bar stock, and cast iron, because the strength of the special HD tips and the perfected design of the tool enable deep cuts and heavy feeds to be taken at intermediate speeds, with amazing tool life.

HD Tools are now available in two styles—11HD and 12HD—for heavy duty turning and boring operations, with special HD tips in Grade KM for general steel cutting, Grade K2S for machining very rough or scaly steel castings, and Grade K6 for cutting cast iron. Larger sizes, i.e., with shanks 1" to 2" wide, are now being produced.

Catalog information, and prices, will be sent immediately upon request.

STREAMLINED DESIGN

Smooth, unimpeded chip flow assured by improved clamping arrangement, correctly positioned. HD design employs pressures set up in cutting as factors to help hold tip in place.



FEWER TOOLS REQUIRED

Many tips can be used during the life of a shank, and tip of suitable Kennametal composition can be used for each job.

KENNAMETAL

SUPERIOR CEMENTED CARBIDES

KENNAMETAL Inc., LATROBE, PA.

charge head. It gives information on how to estimate horsepower requirements, and the size and speed of pulleys. Technical charts and tables show friction loss in pipes, viscosity, viscosity conversion, wiring data and fuse sizes. Helpful hints for installing pumps and tips on trouble-shooting are also included.

The new Roper book, which is devoid of advertising, can be obtained free without obligation from Roper Sales and Service Branches located in principal cities—or by writing the Geo. D. Roper Corp., Rockford, Ill., on your company letterhead.

"How to Run a Lathe"

The South Bend Lathe Works has just issued the 43rd edition of their popular book, "How To Run A Lathe". A number of changes in text material and illustrations have been made since the previous edition was printed in 1942.

This book contains the latest information on the operation and care of metal working lathes. It covers such subjects as the operation of the lathe units, grinding cutter bits, making accurate measurements, plain turning, chuck work, taper turning, boring, drilling, reaming, tapping, cutting screw threads, reference tables, etc. Written clearly and concisely, it is widely used by machinists and as a shop text in schools and apprentice training courses. This edition contains 128 pages—5 1/8" × 8", and over 365 illustrations. Postpaid copies are available with paper covers for 25¢ or with leatherette covers for 75¢, in stamps. Write to South Bend Lathe Works, 385 E. Madison Street, South Bend 22, Ind.

New Bulletin on Wing Fans

A condensed bulletin covering Ventilating and Duct type Fans has been issued by L. J. Wing Mfg. Co., of New York.

It describes the new Wingfoil Fan Wheel, the Wingfoil Straight Line Duct Fan, and the Wingfoil Elbow type Duct Fan. "Duct Fan" is a new designation for what was formerly called an "Exhauster."

The bulletin illustrates many types of installation of the Duct type Fan. The Wingfoil Fan Wheel, especially noted for its "non-overloading" feature is described and illustrated as is the new Wingfoil Safety Fan with direct motor drive as well as V-belt drive. Capacity tables, dimensions and engineering data make this a particularly valuable bulletin for the engineer.

Copy of this publication may be had by writing for Bulletin F-9.

Greensand Zeolite Softeners

Cochrane Corp., Philadelphia, Pa., have available an informative publication on Green Sand Zeolite Softeners.

Power-plant operators, or those interested in the production of soft water, can obtain this informative booklet by writing for Publication 2860-A.

Sure-Flow Centrifugal Coolant Pumps

A new 28-page bulletin, Catalog No. 28, describing the improved line of Sure-Flow Centrifugal Coolant Pumps offered by Logansport Machine Co., Inc., Logansport, Indiana, is now available. The improved line of Logan Pumps, described in the new bulletin, includes twenty-seven sizes and types, each of which is designed to keep pace with the exacting requirements of manufacturers engaged in war production.

Complete details and specifications of the "Logan" Pumps are contained in the above mentioned bulletin, which is now available, free upon request, from the manufacturer. In addition, the new Logansport bulletin includes a great deal of helpful, practical engineering data, such as tables showing friction of viscous liquids and water in pumps.

Heliflow Heat Exchanger

Graham Mfg. Co., 415 Lexington Avenue, New York 17, N. Y., announces their Bulletin No. 58, which describes their new type of Heliflow Heat Exchanger, which is the ultimate in a small heat exchanger . . . a radically different and improved type.

"Heliflow" has been tested, tried and proven throughout two years of exhaustive research and actual installations. It will produce a rate of heat transfer in many cases 40% greater than the conventional heat exchanger.

Bulletin No. 58 tells what the "Heliflow" can do, fully describes and illustrates them, and gives dimensions and other data.

Fuel Oil Atomizers for Pulverized Coal Burners

Bulletin OB-PC, 32 pages describing and illustrating the adaptability of pulverized coal burners for oil firing. Also explaining the advantages of Enco Oil Atomizers for combination pulverized coal and oil fired boilers. The Engineer Co., 75 West St., New York 6, N.Y.

WHEN YOU NEED PRECISION-BUILT SMALL PUMPS . . . Specify TUTHILL

Don't let its small size fool you. This internal-gear, rotary type, mechanically sealed pump does a man-sized job in pressure lubrication service. Equally outstanding for hydraulic mechanisms, fuel oil and liquid transfer. Capacities from .33 to 3 g.p.m. Pressures up to 400 p.s.i. Ring or foot-mounted. Many porting arrangements available. Write for Model L Industrial Bulletin.

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Justrite DRAFTING INK

Courtesy Albert Kahn, Architects

Thousands of Drafting Rooms
Have selected
JUSTRITE
India Black Ink

It flows so freely and will not cake in the bottle nor on your drafting pen. It makes superior reproductions. Offered in 23 highly water-proof colors. ¾-ounce quill-stopper bottle 25 cents at your dealers. Also available in larger sizes.

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